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& HEALTH

Sent via Overnight Courier

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DRAFT PRELIMINARY (30%) REMEDIAL DESIGN REPORT
OPERABLE UNIT 3, POHATCONG VALLEY GROUNDWATER
CONTAMINATION SUPERFUND SITE, WARREN COUNTY, NEW JERSEY

Dear Ms. Granger:

September 28, 2018

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Ref. 1690008019-005

On behalf of Pechiney Plastics Packaging, Inc. (PPPI) and Luis Hidalgo (Rio Tinto), Project Coordinator for OU3, and pursuant to Section IX of the USEPA-approved Statement of Work (SOW)[1] for OU3, the Consent Decree (CD)[2],and the design for the selected remedy identified in the USEPA Record of Decision (ROD)[3] for treatment of soils of Source Area A of OU3, Ramboll US Corporation (Ramboll) submits the enclosed *Draft Preliminary (30%) Remedial Design Report, Operable Unit 3, Pohatcong Valley Groundwater Contamination Superfund Site, Warren County, New Jersey* ("Draft 30% Design Report").

As discussed in the Draft 30% Design Report and following USEPA's review of the current Pre-Design Investigation (PDI) results, data gaps remain to the east and north-east of the Former Molding Room Area (beneath the facility's Main Production Area [MPA]) that require additional characterization. In response to USEPA's request for additional characterization, up to four supplemental soil borings will be installed to complete the PDI and to facilitate final design of the OU3 remedy. Due to access limitations and issues associated with drilling within the MPA during facility operations, the supplemental soil borings will be installed during the next scheduled plant shutdown during the period of December 24, 2018 through January 2, 2019. The results from the supplemental soil borings confirming the final soil treatment volume will be presented in the Pre-Final (90%) Remedial Design Report. From this soil treatment volume, the elements of the *in-situ* thermal remediation (ISTR) system to address the identified deep soil contamination underlying the former ANC building will be scaled accordingly and presented in the Pre-Final (90%) Remedial Design Report.

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1 USEPA approval of the OU3 Statement of Work in a letter dated June 26, 2017.

2 In the matter of United States of America v. PPPI (Civil Action No. 09-cv-05692) and United States of America v. Bristol Myers Squibb Company, et al. (Civil Action No. 13-cv-05798) effective March 11, 2015.

3 USEPA Record of Decision – OU3 Study Area dated September 30, 2016.

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The contents of this Draft 30% Design Report have been reviewed with Albeá Americas, Owner Settling Defendant under the Consent Decree[4] for input in advance of this submittal.

A single hard copy of the Draft 30% Design Report plus copies of the electronic files of this submittal on CD-ROM are enclosed. Should you have any questions concerning this submittal, please do not hesitate to contact us.

Sincerely,

Ramboll US Corporation

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Jeff Armington, Rio Tinto	Cover letter only
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Bruce White, Barnes & Thornburg, LLP	Cover letter + electronic files on CD-ROM

[4] Pursuant to Section VI. Paragraph 12.c(1) of the CD, USEPA approval of the OU3 SOW was received on June 26, 2017.

Prepared for
Pechiney Plastics Packaging, Inc.

Submitted to
United States Environmental Protection Agency
New York, New York

Prepared by
Ramboll US Corporation

Date
September 2018

Project Number
1690008019

DRAFT PRELIMINARY (30%) REMEDIAL DESIGN REPORT

OPERABLE UNIT 3, POHATCONG VALLEY GROUNDWATER CONTAMINATION SUPERFUND SITE WARREN COUNTY, NEW JERSEY

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ACRONYMS AND ABBREVIATIONS

3D	three-dimensional
cm^2	square centimeters
cm/sec	centimeters per second
lb/hr	pounds per hour
mg/kg	milligrams per kilogram
ppm	parts per million
scfm	standard cubic feet per minute
µg/L	micrograms per liter
$µg/m^3$	micrograms per cubic meter
AC1	Area of Concern 1
AIDV	Analytical Interval Data Value
Albéa	Albéa Americas, Inc.
ANC	American National Can
bgs	below ground surface
CD	Consent Decree
CERCLA	Comprehensive Environmental Response, Compensation, and Liability
CO	carbon monoxide
CO_2	carbon dioxide
CQA	construction quality assurance
CQAPP	Construction Quality Assurance Project Plan
CVOCs	chlorinated volatile organic compounds
DNAPL	dense non-aqueous phase liquid
DL	drain lines
DO	dissolved oxygen
DOT	Department of Transportation
DRM	diesel particulate
ECD	electron capture detector
EDD	Electronic Data Deliverables
ENVIRON	ENVIRON International Corporation
ERH	electrical resistance heating
EV	electron volt
EVS	Earth Volumetric Studio
GAC	granular activated carbon
GC	gas chromatograph
GWETS	Groundwater Extraction and Treatment System
HC	hydrocarbons
HCHO	diesel odor
ICs	institutional controls
ICIAP	Institutional Control Implementation and Assurance Plan
IDW	investigative-derived waste
ISTR	*in-situ* thermal remediation
MNA	monitored natural attenuation
MS/MSD	matrix spike/matrix spike duplicate
NELAP	National Environmental Laboratory Accreditation Program
NJDEP	New Jersey Department of Environmental Protection
NPT	National Pipe Tapered
NTUs	nephelometric turbidity units
OM&M	operation, monitoring, and maintenance
ORP	oxygen reduction potential
OU1	Operable Unit 1

OU2	Operable Unit 2
OU3	Operable Unit 3
PCBs	polychlorinated biphenyls
PCE	tetrachloroethene
PDI	pre-design investigation
PID	photoionization detector
PPE	personal protective equipment
PPPI	Pechiney Plastic Packaging, Inc.
PPW	private potable well
PTFP	polytetrafluoroethylene
P/TSE	Pilot/Treatability Study Evaluation
PVGCS	Pohatcong Valley Groundwater Contamination Superfund
QA	quality assurance
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
QC	quality control
RA	remedial action
Ramboll	Ramboll US Corporation
RAOs	Remedial Action Objectives
RAWP	Remedial Action Work Plan
RD	remedial design
RD/RA	Remedial Design/Remedial Action
RDWP	Remedial Design Work Plan
RG	remedial goal
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SEE	steam-enhanced extraction
SOF	soluble organics
SOPs	Standard Operations Procedures
SOTA	state-of-the-art
SOW	Statement of Work
SSD	sub-slab depressurization
SSO	Site Safety Officer
SVE	soil vapor extraction
SVOCs	semi-volatile organic compounds
T&D	transportation and disposal
TBC	to-be-considered
TCH	Thermal Conductive Heating
TOC	total organic carbon
trichloroethene	TCE
TPY	tons per year
TTZ	target treatment zone
UL	Underwriters Laboratories Inc.
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
VTC	Vikon Tile Corporation
VIRA	Vapor Intrusion Removal Action
VMP	vacuum monitoring point
VOCs	volatile organic compounds
WLY	Warren Lumber Yard

1. INTRODUCTION

1.1 Purpose and Scope

On behalf of Pechiney Plastic Packaging, Inc. (PPPI), Ramboll US Corporation (Ramboll) has prepared this Preliminary (30%) Remedial Design Report for the remedy selected by the United States Environmental Protection Agency (USEPA) to address trichloroethene (TCE) impacts in deep vadose zone soils for Operable Unit (OU)3 of the Pohatcong Valley Groundwater Contamination Superfund (PVGCS) Site, hereinafter referred to as "Site" located in Warren County, New Jersey (USEPA ID# NJD981179047). This Preliminary (30%) Remedial Design Report is submitted in compliance with Section IX of the USEPA-approved Statement of Work (SOW)[1] for OU3 and the Consent Decree (CD)[2] and presents the design for the selected remedy identified in the USEPA Record of Decision (ROD)[3] for treatment of soils of Source Area A of OU3 at the Site.

A pre-design investigation (PDI) for OU3 (Source Area A) was conducted to address data gaps where TCE contamination beneath the former ANC building required additional characterization to facilitate design of the remedial action (RA). The data generated from the PDI focused on refining the treatment volume for the proposed remedy (i.e., the unsaturated soils with concentrations of TCE greater than 1 mg/kg). Based on the results of the OU3 PDI activities conducted at the site from March 13 to August 6, 2018, preliminary estimates are that approximately 17,000 cubic yards of soil contains TCE concentrations greater than 1 mg/kg.

USEPA's review of the current PDI results indicated that data gaps remain to the east and north-east of the Former Molding Room Area (beneath the facility's Main Production Area (MPA) that require additional characterization. In response to USEPA's request for additional characterization, up to four supplemental soil borings are planned for installation to confirm the remaining volume of soil to be treated for incorporation into the Pre-Final (90%) Design for OU3. Due to access limitations and issues associated with drilling within the MPA during facility operations, the supplemental soil borings will be installed during the next scheduled plant shutdown during the period of December 24, 2018 through January 2, 2019. The results of these supplemental soil borings confirming the final soil treatment volume will be presented in the Pre-Final (90%) Remedial Design Report. From this soil treatment volume, the elements of the in-situ thermal remediation (ISTR) system to address the identified deep soil contamination underlying the former ANC building will be scaled accordingly and presented in the Pre-Final (90%) Remedial Design Report.

1.2 Site Description

The Pohatcong Valley Contamination Superfund (PVGCS) Site encompasses an area of about 16.5 square miles (10,600 acres) that extends about 8.5 miles along the length of the Pohatcong Valley, which is a northeast-southwest trending valley bounded by mountains. The location of the PVGCS Site is shown in Figure 1. The Site is divided into three operable units. Operable Unit 1 (OU1), which covers about 8.75 square miles extending about 5 miles along the Pohatcong Valley,

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[1] USEPA approval of the OU3 Statement of Work in a letter dated June 26, 2017.

[2] In the matter of United States of America v. PPPI (Civil Action No. 09-cv-05692) and United States of America v. Bristol Myers Squibb Company, et al. (Civil Action No. 13-cv-05798) effective March 11, 2015.

[3] USEPA Record of Decision – OU3 Study Area dated September 30, 2016.

is defined by the USEPA as the study area established to address TCE and tetrachloroethene (PCE) contaminated groundwater within Washington Borough, and parts of Washington and Franklin Townships. OU2 is defined by the USEPA as the portion of the Site downgradient from OU1 where TCE is present in groundwater. The OU3 Study Area is located in Washington Borough and is defined by the USEPA as the area that has been identified as the source area for TCE within the aquifer. The OU3 Study Area comprises four properties known as: ANC Area of Concern 1 (AC1), Vikon Tile Corporation (VTC), and Warren Lumber Yard (WLY) properties. A site map showing the location of OU3 is presented on Figure 2. This Preliminary (30%) Remedial Design Report focuses on remediation of Source Area A, which contains the deep TCE-contaminated soils underlying the southwestern portion of the former ANC building identified as the volume of soils to be treated in the USEPA's ROD for OU3.

The currently active facility consists of the one main building, which houses administrative offices, production facilities, raw and waste materials storage areas, and warehouse shipping and receiving operations for the current property owner, Albéa Americas, Inc. (Albéa). The eastern portion of the property consists of an unused, vegetated land that borders State Highway 31. The northern side of the building is a shipping and receiving area that includes loading docks, equipment storage areas, and raw materials and drum storage. A local control panel and four injection wells for discharge of treated effluent from the Groundwater Extraction and Treatment System (GWETS) for OU1(TCE in groundwater) are also located at the north end of the property. The western side of the building includes a paved area that contains raw material storage silos, a water tower, above ground storage tank and pump house for the fire suppression system for the facility, electrical distribution equipment, a fifth injection well for the GWETS, and the soil vapor extraction (SVE) blower shed and off-gas treatment equipment for the sub-slab vapor intrusion mitigation system installed as part of the Vapor Intrusion Removal Action in 2013. The vapor intrusion mitigation systems are described in further detail in Section 1.5.

Source Area A within OU3 has been defined as the soils beneath the southwestern portion of the ANC building also known as the former Molding Room area inside the building and drain lines (DL) DL-9 and DL-10, which connect to discharge structures on the down slope portions of the ANC property and originate in this area of the ANC building (USEPA, 2016a). Recent pre-design investigation (PDI) activities conducted from March to June 2018 within the former Molding Room area identified that soil impacts in this area also extend further to the east beneath the Main Production Area of the facility.

1.3 Background

In 2011, USEPA initiated OU3 Study Area Remedial Investigation/Feasibility Study (RI/FS) activities to determine the nature and extent of contamination. The RI included an evaluation of potential human health and ecological risks based on Site-related contamination in soil, sediment, surface water and indoor air. As a result of these activities, USEPA issued a ROD for OU3 in September 2016. As provided in the OU3 ROD and SOW, the major components of the USEPA-selected remedy for OU3 include the following:

- The implementation of deep SVE and/or thermal treatment to address deep soil contamination underlying the former ANC building.
- Long-term operation and maintenance of the existing shallow SVE and SSD systems within the former ANC building.

- Long-term groundwater and indoor air monitoring in the OU3 Study Area.

- Continued implementation of ICs, including the existing deed notice, and amendment to reflect the components of the selected remedy for OU3 that will be implemented at the former ANC property.

PPPI is conducting the remedial activities at the PVGCS Site pursuant to the CD that became effective on March 11, 2015. The OU3 Source Area A soil treatment portion of the project is being performed in accordance with the OU3 SOW, which defines the requirements for implementation of the Remedial Design (RD), the Remedial Action (RA), and Operations, Monitoring and Maintenance (OM&M) for OU3. The OU3 SOW was approved by the USEPA on June 26, 2017 and incorporated into the CD.

During the summer of 2013 as part of the Vapor Intrusion Removal Action (VIRA), a vapor mitigation system (consisting of shallow sub-slab soil vapor extraction (SVE) points were installed in the former Molding Room area and along the western wall of the Main Production Area powered by a 500 cubic feet per minute SVE blower with vapor phase granular activated carbon for treatment of extracted vapors) and shallow sub-slab depressurization (SSD) systems located within the Main Production Area were installed to mitigate exposure to TCE vapors inside the building. Results of subsequent sampling show the systems have reduced concentrations of TCE in the indoor air and sub-slab vapor to below the Site-specific indoor air health goal of 7 micrograms per cubic meter ($\mu g/m^3$).

1.4 Site Geology and Hydrogeology

The PVGCS Site is located within the Pohatcong Valley, which falls within the Reading Prong portion of the Highlands Physiographic Province, locally referred to as the New Jersey Highlands Province. This province is characterized by northeast-southwest trending ridges and valleys of Late Precambrian metamorphic and igneous rocks, and Early Paleozoic carbonate rock.

The Pohatcong Valley trends northeast-southwest and is bounded on the southeast and northwest sides by regional faults (the Pohatcong Thrust Fault along the southeast side and the Brass Castle Thrust Fault along the northwest side). A third fault (the Karrsville Thrust Fault) is suspected to be present along the Valley floor. The topographic ridges to the southeast and northwest of the Valley floor are both formed from relatively hard and erosion-resistant igneous and metamorphic rocks of Precambrian Age that were thrust up in the area during the Paleozoic Era. The Valley floor is underlain by Early Paleozoic (Cambrian and Ordovician) units that are primarily composed of carbonate rocks (limestones and dolomites) of the Jackson Limestone and the Kittatiny Supergroup. The Kittatiny Supergroup includes the Leithsville Formation, Allentown Dolomite, Lower Beakmantown Group, and the Upper Beakmantown Group. The upper part of the Valley where the existing groundwater extraction and treatment system is operated is underlain by the Leithsville Formation, which is characterized as an approximately 1,000-foot thick unit that consists of dolomite, calcitic dolomite, and phyllite with thin beds of dolomite-cemented quartz. This formation and the other bedrock formations located farther down the Valley contain numerous karstic features (i.e., sinkholes, caves, large fractures, and cavities) and are primarily composed of carbonate units that readily form karst.

The carbonate rocks under the Valley floor are overlain by unconsolidated sedimentary deposits of glacial origin, primarily glacial till, glacial moraine, and glacio-fluvial deposits that range in thickness from about 40 feet near the boundary between OU1 and Operable Unit 2 (OU2) (i.e., down valley) to about 100 feet near the northeastern boundary of OU1. These glacial deposits are generally characterized as a heterogeneous and poorly sorted mixture of gravel, sand, silt, and clay. In most areas, this material has a low permeability and is primarily composed of clayey silt. Slightly greater permeability is encountered in some strata that contain silty sand and gravel lenses.

The glacial till, moraine and fluvial unconsolidated overburden deposits immediately below the building are characterized as predominantly silt to approximately 88 feet below ground surface (bgs) to 109 feet bgs. The silt coarsens downward often becoming sandier towards the bedrock interface. The silt is characterized by having trace cobbles and boulders, is dry, and hard. In some boreholes, a cobble or boulder layer was encountered. These layers ranged in length and depth. The shallowest boulder/cobble layer was encountered around 16 feet bgs while the deepest cobble/boulder layer was encountered around 90 feet bgs. Below the silt overburden, weathered dolostone/limestone bedrock is encountered. Generalized geologic cross-sections of the OU3 Source Area to be treated are presented in Figures 3A and 3B.

Groundwater in the Pohatcong Valley is found in perched zones within the unconsolidated deposits and in a regional aquifer in the deep overburden and bedrock. Although some perched water zones are present, they do not represent a significant source of groundwater for the region; are generally isolated from each other; and do not form one coherent aquifer. The regional bedrock stratum is primarily composed of fractured and karstic dolomite. Groundwater in the regional aquifer is generally encountered at a depth of approximately 80 to 110 feet bgs in the northern part of OU3 where active remediation is proposed and at progressively shallower depths farther down valley (i.e., towards the southwest). The depth to groundwater at POHMW12 located within OU3 Source Area A ranges from approximately 120 feet bgs to 129 feet bgs.

1.5 Vapor Intrusion Mitigation Systems

During the summer of 2013, shallow sub-slab SVE and SSD systems were installed as part of the VIRA activities at the facility to mitigate exposure to TCE inside the building. The SVE/SSD systems were designed to reduce concentrations of TCE in indoor air to levels below the Site-specific indoor air health goal of 7 $\mu g/m^3$ by inducing negative pressures (vacuum) beneath the building slab.

The SVE/SSDS system consists of a total of 16 vapor extraction points. These vapor extraction points are located in the former Molding Room area, Main Production Area, and Maintenance Area of the facility. The SVE wells points were constructed to a maximum depth of approximately 4 to 5 feet below the concrete slab. From each extraction wellhead, soil vapor is conveyed through to a SVE blower shed located outside the western wall of the building. The installed SVE blower is designed to operate at flow rates up to 500 cubic feet per minute (CFM). Sub-slab vapors extracted by the SVE blower are discharged through a heat exchanger followed by two vessels in series each containing 2,000 pounds of vapor-phase granular activated carbon.

A standby 100 CFM blower system is integrated into the main SVE/SSD system as a backup system and is operated in the event the 500 CFM SVE blower is non-operational or shut down for an extended period. The 100 CFM system is connected to the main conveyance piping headers that are connected to the vapor extraction points located within the former Molding Room area and is designed to operate as an auxiliary SSD system to maintain negative pressures beneath the slab in the area where highest TCE vapors are present. The 100 CFM standby system includes two 200-lb reactivated vapor-phase Granular Activated Carbon (VGAC) units, operated in series (lead/lag configuration) to comply with air discharge permit requirements.

To further supplement the 500 CFM system should it become non-operational or shut down for an extended period, five vapor extraction points located along the western wall of the Main Production Area (SSDS-06 through SSDS-10) are utilized as standby SSDS points. These five SSDS points are connected to three independent regenerative type blowers located on the exterior of the building on the upper mezzanene level of the facility. This west wall SSDS system is designed to automatically start if the main 500 CFM system shuts down. In addition to the west wall SSDS, five SSDS extraction points (SSDS-01 through SSDS-05) located along the eastern wall of the Main Production Area are operated continuously to provide an additional measure of protection. This east wall SSDS system utilizes five independent radon type blowers that are located on the eastern exterior wall of the building.

Monitoring of the SVE/SSD systems are performed on a monthly basis in which sub-slab vacuum measurements and VOC concentration readings using a photoionization detector (PID) are collected from sub-slab vapor monitoring ports located throughout the facility. In addition, system operation parameters such as blower flow rate, pressure, vacuum, temperature, and vapor concentrations at the lead/lag carbon vessels are recorded for perfomance monitoring and reporting purposes. Additional details on the design and layout of the SVE/SSD system are presented in the Operation, Maintenance, and Monitoring Plan contained in the Remedial Design Report for the Vapor Intrusion Response Activities (Ramboll Environ US Corporation, 2015). The layout of the SVE/SSDS extraction and sub slab vapor monitoring points are presented in Figure 4.

1.6 Efforts to Secure Site Access

Ramboll has worked closely with the Owner Settling Defendant to the CD, Albéa, to integrate their operational and health and safety constraints into both the remedial design and the remedial actions of OU1 (TCE) and the VIRA activities on the former ANC property. Most recently, Ramboll and PPPI have worked closely with Albéa to coordinate implementation of the PDI soil boring program and SVE pilot testing activities to minimize adverse impacts on the Washington Facility plant operations.

Albéa remains committed to complying with its obligations under the CD to provide access to the site for PPPI to implement the RA for OU3. In addition, PPPI is in discussions with Albéa to reach an agreement for Albéa to move its current operation from the former Molding Room area to an off-site warehousing location such that the former Molding Room area will be available for the necessary duration for implementation of the RA for OU3. This will enable the installation of all the planned heater borings from within the former Molding Room area to reach the target treatment zone for the OU3 RA as presented in this Preliminary (30%) Remedial Design Report.

1.7 Remedial Design Objectives

As stated in the ROD, the requirements of the selected remedy are to:

- address deep soil contamination underlying the former ANC building having TCE concentrations greater than 1 mg/kg;

- Perform long-term operation and maintenance of the existing shallow SVE and SSD systems within the former ANC building; and

- Conduct long-term groundwater and indoor air monitoring in the OU3 Study Area.

- Implementation of ICs, including the existing deed notice, and amendment to reflect the components of the selected remedy for OU3.

The remediation approach and design objective for OU3 Source Area A is to minimize the time to meet the required remediation goal by effectively heating the subsurface in a sufficient manner to increase the soil temperature in the target treatment area to achieve the clean-up goal of 1 mg/kg TCE in soil. Additionally, the in-situ thermal remediation system design shall accomplish the following:

- Control in-situ pressure to prevent the migration of steam, vapors, or water to migrate toward the surface or laterally within the treatment volume;

- Capture and treat vapors to remove, recover, or destroy VOCs; and

- Operate the process treatment components of the remediation system to meet applicable discharge criteria.

The design of the remedy for OU3 Source Area A includes instrumentation, control systems and components that allow timely data acquisition, reporting, interpretation, and decision making to verify that operational requirements and the design objectives are being met, and to optimize each component of the remediation system. These systems will also ensure that the treatment progress is accurately tracked, that the mass of TCE removed is measured, and that operation of the system complies with regulatory standards and meets the necessary health and safety requirements for protection of human health and the environment.

1.8 Report Organization

As described in the sections that follow, this report provides the design for the installation and implementation of an in-situ thermal remediation (ISTR) system to address the identified deep soil contamination underlying the former ANC building:

- Section 2 – Basis of Design
- Section 3 – In-Situ Thermal Remediation System Design
- Section 4 – Permitting
- Section 5 – Remedial Construction
- Section 6 – Waste Management
- Section 7 – Operations Maintenance and Monitoring
- Section 8 – Post Remediation Verification Sampling Plan
- Section 9 – Health and Safety
- Section 10 – Institutional Control implementation and Assurance Plan
- Section 11 – Schedule
- Section 12 - References

These sections are discussed in detail below. The appendices provide the thermal desorption modeling report (Appendix A), Preliminary Design Drawings (Appendix B), Technical Specifications table of contents (Appendix C), a draft Construction Quality Assurance Project Plan (Appendix D), a Draft Waste Management Plan (Appendix E), a Preliminary Thermal Conductive Heating System Commissioning Checklist (Appendix F), and table of contents for an Operations, Maintenance and Monitoring Plan (Appendix G).

2. BASIS OF DESIGN

2.1 Remedial Action Goals and Objectives

The primary objectives of this action are to remediate the source soils that are contributing to groundwater and indoor air contamination at the Site and minimize potential future health and environmental impacts from site-related contaminants. The USEPA-defined Remedial Action Objectives (RAOs) for OU3 are:

- Reduce TCE contaminant mass in the vadose-zone soil to minimize the impact to groundwater quality;
- Reduce TCE contaminant mass in the vadose-zone soil to minimize the potential human-health risks from vapor intrusion; and
- Mitigate impacts to public health resulting from existing, or potential, soil vapor intrusion into buildings.

To achieve the RAOs, the following remediation goal (RG) was set by the USEPA for this action (Table 8 of the ROD):

- Site-specific RG of 1 mg/kg for TCE in the vadose-zone soil, based on modeled calculations that demonstrate that a TCE soil concentration of 1 mg/kg would result in minimal impact to TCE concentrations in groundwater at the OU1 groundwater extraction and treatment system wells.

A pre-design investigation (PDI) for Operable Unit OU3 (Source Area A) was conducted to better define the extent of contamination beneath the Albéa building (i.e., the unsaturated soils with concentrations of TCE greater than 1 mg/kg), address data gaps exist in areas along the southern, western, and eastern boundaries of the estimated extent of the TCE impacts, ensure that the remedy targets the appropriate unsaturated soil areas, and to facilitate design of the RA. The results of the PDI are discussed in Section 2.2 below.

2.2 Pre-Design Investigation Soil Sampling Results

The results of the PDI activities conducted at the Site from March 13 to August 6, 2018 in accordance with the Remedial Design Work Plan (Ramboll, 2018a) are summarized below. Additional details describing the borehole drilling methods, sampling procedures, and pre-design investigation activities are presented in the Draft Soil Vapor Extraction Pilot/Treatability Study Evaluation (P/TSE) Report (Ramboll, 2018b).

After completion of the PDI activities in August 2018, USEPA indicated that supplemental soil borings were needed to the north and east of PDI-SB25 and PDI-SB26 beneath the facility's MPA to determine the extent of the TCE soil impacts above the RG of 1 mg/kg. In response to USEPA's request for additional soil borings, up to four supplemental soil borings are planned for installation during the next scheduled plant shutdown during the period of December 24, 2018 through January 2, 2019. The results from these supplemental soil borings confirming the final soil treatment volume will be presented in the Pre-Final (90%) Remedial Design Report.

2.2.1 Description of Soils Encountered

The soils encountered in the borings completed during the PDI investigation are alluvium and pre-Wisconsin drift, with some weathered bedrock. The soil was largely composed of silt and clays with varying amounts of sand and gravel. Some boulders and cobbles were encountered and were described as mainly granitic or gneissic with rare quartzite, amphibolitic, and shale cobbles. The grain size analysis conducted indicated that soils were generally finer-grained with depth. Soil particle size analysis on samples collected during the PDI confirms that a significant percentage of silt and clay is present (average of 37%) at depths greater than 60 feet bgs. Competent bedrock was encountered beneath the former Molding Room area from approximately 129 to 146 feet bgs.

2.2.2 Extent of Soil TCE Impacts in OU3 Source Area A

Concentrations of TCE in soil greater than 1 mg/kg were detected at all the PDI borings except for borings PDI-SB01A, PDI-SB05, PDI-SB-10, PDI-SB11, PDI-SB15, PDI-SB17, PDI-SB21A, and PDI-SB22A; TCE impacts above 1 mg/kg were also detected at boring VMP-1. With minor exceptions the impacts above 1 mg/kg are generally confined to beneath the former Molding Room area except in an easterly direction (i.e. extending beneath the Production Area). Depth-wise the impacts to soil greater than 1 mg/kg are located from approximately 60 feet bgs to 122 feet bgs, with the shallowest occurrences in the former Molding Room Area at 60 to 80 feet bgs (PDI-SB03, PDI-SB06, PDI-SB09, PDI-SB20, and PDI-SB23), and deeper occurrences detected beneath the Production Room Area at approximately 85 to 122 ft bgs (PDI-SB19A, PDI-SB24A, PDI-SB25 and PDI-SB26).

The highest concentrations of TCE in soil detected during the PDI are present near the former trench drain in the former Molding Room area at Borings PDI-SB18, PDI-SB20 and VMP-1 at depths ranging from approximately 60 to 80 feet bgs; with the maximum detected TCE concentration in soil of 44.1 mg/kg at PDI-SB20 at 79.5 to 80 feet bgs.

A 2-D plan view and cross-sectional view of the TCE soil impacts are depicted on Figures 5A and 5B. A 3-D representation of the EVS model depicting the extent of the TCE impacts greater than 1 mg/kg is provided in a four-dimensional interactive model (DIM) animation file in the Draft P/TSE Report (Ramboll, 2018b).

2.2.3 Site Conceptual Model

Multiple investigations conducted at OU3 Source Area A indicate that immiscible phase TCE or high concentrations of TCE in solution were released to the environment from floor drains, sumps, and a drain line in an area within the ANC building referred to as the former Blak-Sol Operations Area (AOC 33) where these solvents were used. These releases occurred from the early 1950s until the 1980s. TCE-impacted wastewater or storm-water conveyed through the drain pipes leaked into the subsurface and enhanced the downward migration of contaminants through the thick (greater than 100 feet) vadose zone, which resulted in impacts to the regional aquifer.

Based on the results of the PDI investigation, the upper 60 feet of glacial till in the Source Area A vadose zone are characterized by higher permeability materials and/ or higher permeability vertical pathways and that the lower portion of the vadose zone from 60 to 120 feet bgs is characterized by lower permeability soils that lack higher permeability vertical pathways. Based on the anisotropic nature of the vadose zone soil, contaminants migrated preferentially through relatively high permeability vertical pathways prior to encountering low permeability lenses. The contamination then migrated laterally prior to encountering other relatively high vertical permeability pathways. While migrating through relatively high permeability pathways, a portion of the TCE mass has been retained in the soil by capillary forces within the porous media or adsorbed onto the surfaces of the soil particles. Diffusion of the TCE mass into the soil matrix has also occurred, while a portion of the TCE mass within shallow soils has volatilized over time.

This SCM is based on the results of the PDI soil borings that show an absence of shallow source area vadose soil TCE impacts in excess of the 1 mg/kg RG from 0 to 60 feet below the building slab , soil physical characteristic data that show the average grain size of the materials decrease with depth, total organic carbon (TOC) data in soil samples that range from 38 mg/kg to 1,500 mg/kg with higher TOC concentrations being detected within deeper soil samples, the distribution pattern of TCE impacted soils through the vadose zone, and decreasing soil air permeability with depth in the vadose zone from data collected from the SVE staggered depth pilot tests.

The depth to groundwater at OU3 Source Area A ranges from approximately 120 feet bgs to 129 feet bgs based on historical water level measurements collected at POHMW12 located within the former Molding Room area. The TCE remaining in the unsaturated soils in Source Area A may potentially be an ongoing source of groundwater contamination and vapor migration to indoor air.

2.2.4 Treatment Volume

Based on the three-dimensional modeling performed using Environmental Visualization System (EVS) software during the PDI (Ramboll, 2018b) and the extent of the model-interpolated volume of TCE impacted soils to the east of the former Molding Room area, the volume of impacted soils greater than the RG of 1 mg/kg is calculated to be approximately 17,000 cubic yards. This soil volume is depicted on Figures 5A and 5B. Note that the 17,000-cubic yard model-interpolated or projected volume shown on Figures 5A and 5B is estimated based on the results from the PDI activities completed through August 2018. This treatment volume will be confirmed after the supplemental soil borings are installed during the next scheduled plant shutdown during the period of December 24, 2018 through January 2, 2019 and presented in the Pre-Final (90%) Remedial Design Report.

2.3 Soil Vapor Extraction Pilot Testing Results

SVE pilot testing activities performed inside the former Molding Room area of the ANC Building were completed to evaluate the effectiveness of using deep SVE to achieve the OU3 RG of 1 mg/kg TCE in soils within Source Area A. For the SVE pilot testing, variable flow rate (step) tests were performed for the first phase of the testing activities to evaluate air flow losses and determine the relationship between applied vacuum and air extraction flow rates at each SVE pilot test well. The step tests also determined the optimal air extraction flow rates for which the constant-rate testing would be performed. The step tests indicated that high levels of vacuum on the order of 250 inches of water column (w.c.) applied at the SVE wellhead (or 22 inches of Mercury (Hg) at the SVE blower) resulted in a corresponding air extraction rate of 44 acfm (17 scfm) at SVE-1A (screened at 20 to 30 feet bgs), 9 acfm (3.5 scfm) at SVE-1B (screened at 60 to 70 feet bgs), and 8 acfm (3.0 scfm) at SVE-1C (screened 100 to 110 feet bgs).

After performing the step tests, constant-rate SVE testing was performed to determine the pneumatic conductivity of the subsurface soil and to estimate the soil pore gas velocity and corresponding airflow radius of influence resulting from the maximum applied airflow extraction rate at each of the three pilot test wells. For SVE to be effective in the transmission of air through the subsurface soil an intrinsic permeability greater than 10^{-9} square centimeters (cm^2) (10^{-12} ft^2)

is recommended (USACE, 2002). The intrinsic permeability is a measure of the ease with which a porous medium can transmit air, water, or other fluids. In addition, a minimum pore-gas velocity of 0.01 cm/s (or 28 ft/day) is recommended to achieve sufficient VOC removal rates for SVE to be effective without requiring unacceptably close SVE well spacing in accordance with the guidance documents: *Engineer Manual on Soil Vapor Extraction and Bioventing* (USACE, 2002) and *Development of Recommendations and Methods to Support Assessment of Soil Venting Performance and Closure* (USEPA, 2001). Based on the constant-rate test data results, the intrinsic permeability of the subsurface soils were estimated to be on the order of 10^{-8} to 10^{-9} cm^2 (10^{-11} to 10^{-12} ft^2) for the shallow zone (0 to 40 feet bgs), 10^{-10} cm^2 (10^{-13} ft^2) for the intermediate depth zone (40 to 80 feet bgs), and 10^{-11} cm^2 (10^{-14} ft^2) for the deep zone (80 to 120 feet bgs). The values for the intermediate and deep soil zones are below the recommended intrinsic permeability for which SVE would be effective in transmitting air. In addition, the calculated airflow radius of influence to achieve the minimum pore-gas velocity of 28 ft/day for each vertical depth interval is approximately 21 to 42 feet for the shallow zone (0 to 40 feet bgs), 3.5 to 13.5 ft for the intermediate depth zone (40 to 80 feet bgs), and 3.5 to 8 ft for the deep depth zone (80 to 120 feet bgs). These results conclude that for SVE to be effective in achieving the necessary pore gas velocities to effectively reduce TCE concentrations to meet the RG of 1 mg/kg, an unacceptably close SVE well spacing would be required.

During the constant-rate testing, soil gas composition data (carbon dioxide (CO_2), oxygen (O_2), methane (CH_4), and total VOCs) were monitored near the conclusion of each constant-rate test to evaluate changes in soil gas within the vadose zone to confirm pore volume exchange during SVE testing. These data were collected from three subsurface vapor monitoring points (VMP) installed for the pilot test. Each VMP was constructed with eight monitoring ports at specific depths throughout vertical unsaturated soil profile. The depths for the VMP monitoring ports were: 5 feet bgs; 15 feet bgs; 25 feet bgs; 35 feet bgs; 45 feet bgs; 65 feet bgs; 85 feet bgs; and 105 feet bgs. Based on measurements collected during the constant-rate SVE tests, there were little to no changes in CO_2, O_2, CH_4, and VOCs observed, demonstrating a lack of vapor flow during the SVE pilot test.

Additional details on the SVE pilot testing results are included in the Draft Soil Vapor Extraction Pilot/Treatability Study Evaluation (P/TSE) Report (Ramboll, 2018b). Based on the results of the SVE pilot testing performed, deep SVE for treatment of OU3 soils is not considered practicable and is not considered as a technology in this Preliminary (30%) Remedial Design Report.

2.4 ISTR for Remedial Design

The remedy selected by the USEPA as presented in the ROD includes the implementation of deep SVE and/or thermal treatment to address deep soil contamination underlying the Albéa Washington Facility building. Based on the results of the PDI soil sampling activities and the SVE pilot testing presented above, deep SVE is not considered to be practicable and in situ thermal remediation using Thermal Conductive Heating (TCH) is the preferred remedial technology for OU3 (Source Area A).

A technical evaluation of various thermal remediation technologies was performe4d to determine if electrical resistive heating (ERH), TCH or steam-enhanced extraction (SEE) is the optimal thermal remediation technology for the Site based on safety, soil characteristics, treatment zone geometry, design and implementation factors, effectiveness in achieving derived site-specific RG and RAOs, and cost. Based on this evaluation, TCH is proposed as the preferred manner for implementation of the ISTR technology for OU3 at the Site based on the following factors:

- The subsurface permeability within the target treatment zone (TTZ) is too low to support SEE;

- ERH is best suited for saturated formations, as electrodes can dry out above the water table, resulting in impeded power delivery to the subsurface;

- TCH borings are installed within smaller diameter boreholes than those associated with ERH electrodes, such that the scope of drilling and waste handling is substantially less than that associated with ERH, particularly in light of the recommended angled thermal system installation approach;

- Under the TCH approach, desiccation near each heater boring is desirable as it facilitates vapor extraction from the vicinity of the heaters (the co-located extraction wells will provide better pneumatic control and capture of vapors than is possible during ERH);

- Implementation of TCH does not involve injection of water, such that no injection permit is required and dedicated liquid extraction wells are unnecessary;

- Based on numerous demonstrations and case studies, TCH will readily reduce TCE concentrations in soils to meet the OU3 RG of 1 mg/kg;

- The TCH heater elements are rated by Underwriters Laboratories Inc. (UL) as intrinsically safe, and no electrical power is applied to the soil itself (unlike ERH where a voltage is induced within the formation, potentially raising health and safety concerns as the thermal remediation will be conducted beneath an operating facility); and

- No pilot or treatability studies are necessary in the design for TCH as discussed below. Once the soils targeted for treatment have been identified, the heater placement and geometry can be defined, and the duration of treatment for soils to reach the desired temperature can be estimated through numeric modeling.

For TCH, pilot or treatability studies are not necessary to perform the RD for this technology based on the following:

- TCE is a simple target contaminant which has been successfully treated in soils to concentrations lower than 1 mg/kg routinely – multiple case studies are available, including peer-reviewed papers.[4,5,6] A summary of representative case studies are

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[4] Heron, G, K. Parker, S. Fournier, P. Wood, G. Angyal, J. Levesque, and R. Villecca. 2015. World's Largest In Situ Thermal Desorption Project: Challenges and Solutions. Groundwater Monitoring & Remediation 35, no. 3/Summer 2015/pages 89–100.

[5] Heron, G., K. Parker, J. Galligan and T.C. Holmes. 2009. "Thermal Treatment of 8 CVOC Source Areas to Near Nondetect Concentrations." Ground Water Monitoring and Remediation. 29 No. 3 / Summer 2009, pp. 56-65.

[6] Heron, G., J. LaChance, and R. Baker. 2013. Removal of PCE DNAPL from Tight Clays using In Situ Thermal Desorption. Ground Water Monitoring and Remediation, 33(4): 31-43.

presented in Table 1. TCE boils at 87ºC as a liquid and is readily removed at temperatures near 100 ºC, which will be the target treatment temperature in implementation of TCH as the ISTR technology for the Site.

- The tight nature of the soils may raise concerns as to how the TCE will be extracted from the subsurface under this condition, which has been addressed in detail and published.[7] As is discussed in Section 3 below, the proposed thermal treatment design approach is to use co-located SVE wells next to each heater, and to follow state-of-the-art procedures and best practices.

- Laboratory treatability tests will not improve estimates for heating duration and treatment time. However, numerical modeling will be used in the design for TCH to implement ISTR for OU3.

The effectiveness of TCH technology in reliably achieving cleanup goals in soil and groundwater has been demonstrated at full scale for a wide variety of contaminant types (e.g., chlorinated volatile organic compounds [CVOCs], semi-volatile organic compounds [SVOCs], coal tar, polychlorinated biphenyls [PCBs]) and hydrogeologic settings (above and below the water table, in sandy, silty and clayey soil, and in fractured rock). TCH projects are frequently completed and sites closed after less than one year of heating. In contrast, projections of the required duration of treatment for other in-situ thermal technologies have frequently proven to be overly optimistic. Mass removal is often detected initially, but due to subsurface heterogeneity and associated mass transport limitations, the required treatment and monitoring period often persists for many years. TCH is fundamentally different because thermal conductivity is nearly invariant even within heterogeneous sites. As such, once it is demonstrated that source zones targeted for treatment have been fully heated, further rounds of treatment are not required.

The basis for the TCH technology in achieving the RG and RAOs is discussed in further detail below.

2.5 In Situ Thermal Remediation – Basis of Design

The following sections describe the basis for design of the thermal remediation using TCH planned for the Site.

2.5.1 Thermal Conductive Heating

The subsurface will be heated to near the boiling point of water, 100 degrees Celsius (°C), using TCH. Heating the subsurface to these temperatures ensures that TCE becomes volatile and partitions into the vapor phase for extraction as the boiling point for free-phase TCE is 87.2 °C. The effectiveness of TCH results from changes in the thermodynamic conditions in the subsurface during heating. The primary characteristic leading to effective thermal treatment is contaminant vaporization whereby a reduced boiling point is observed for contaminants in situ. The diagrams below illustrate changes to the physical properties of TCE and PCE[8] as temperatures increase. As

[7] Ibid.

[8] Although PCE is not a contaminant of concern at the site, PCE and TCE have similar physical behaviors such as 1) TCE boils at 87 C and PCE at 121 C; 2) TCE solubility is 1,100 mg/l and the solubility of PCE is 140 mg/L; 3) neither of these chemicals hydrolyze; and 4) both can only be removed by vaporization at realistic time-scales. As such, PCE is less volatile than TCE, and is therefore more difficult to treat than TCE. Because of this, case studies for both contaminants have been included to demonstrate the success of TCH to treat TCE (and even the slightly more recalcitrant PCE) under a wide range of site conditions.

depicted, vapor pressure and Henry's Law constants increase dramatically as temperatures rise, allowing COCs to vaporize below their characteristic boiling points.

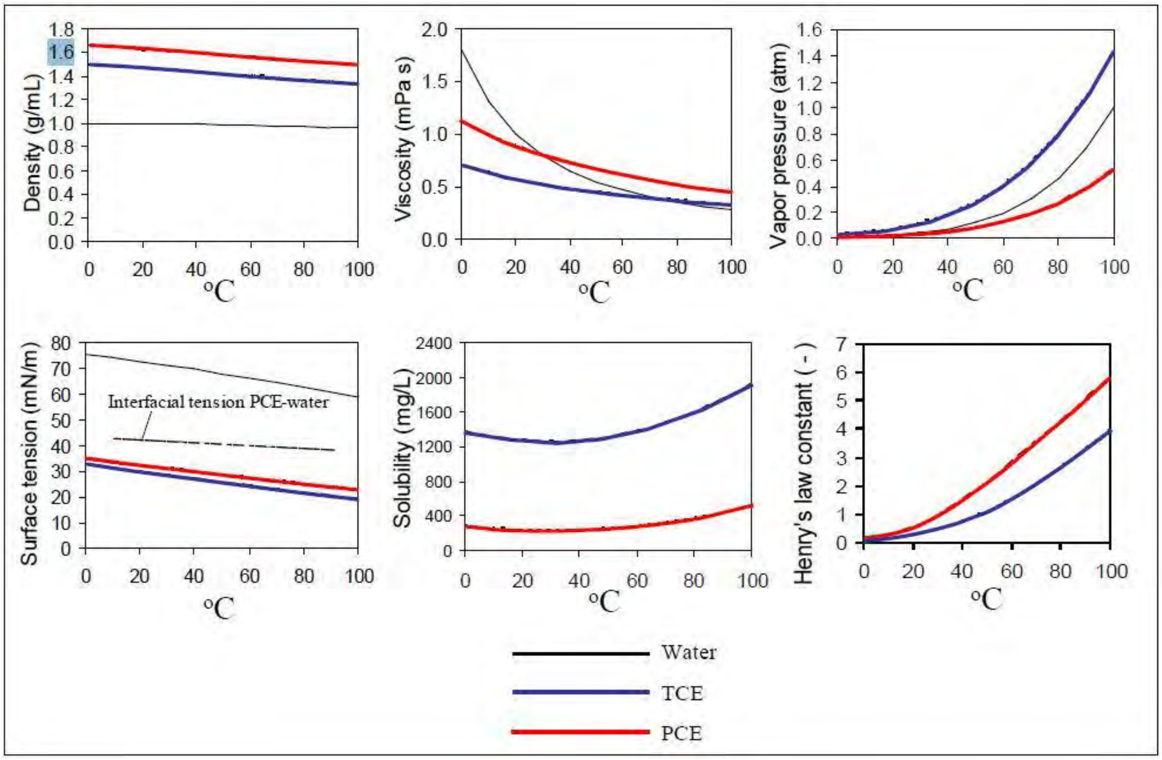

Illustration of Physical Property Changes as a Function of Temperature

Vaporization is further depicted in the below illustration (Ambient vs Boiling Temperature Illustration at the Pore Scale) where two images of the same porous medium compare heated and unheated pore water. The left image is at ambient temperatures and the right image is at boiling temperatures. Contaminant vaporization is illustrated by comparing the lighter areas (gases in the pore space) between the two pictures. The observed increase in gas volume as temperature is increased demonstrates how boiling temperatures lead to steam formation. The continuous gas phase in the image to the right depicts the boiling of pore fluids and the creation of steam. The steam is rich in contaminant vapors under pressure and inclined to move out of the pore matrix.

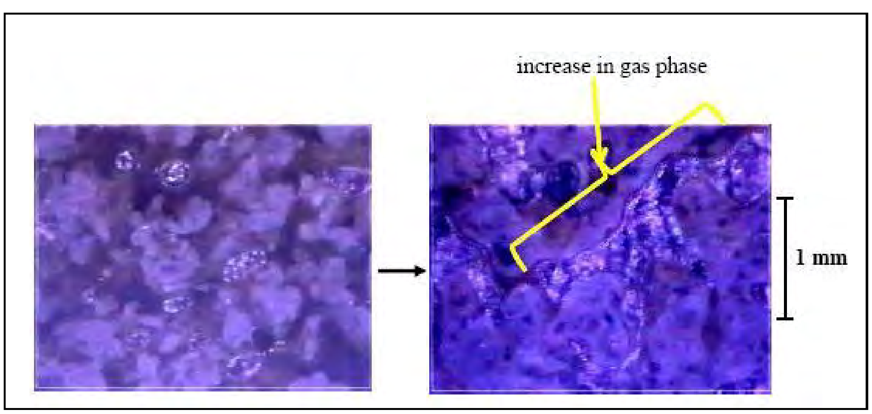

Illustration of Ambient vs Boiling Temperature at the Pore Scale

Similar mechanisms occur at non-aqueous phase liquid (NAPL)-water interfaces where contaminant rich vapors are produced and inclined to move as boiling temperatures are reached. When heating the Site COCs, the following will occur:

- COCs become more mobile and therefore more easily removed from the subsurface when heated to temperatures around the boiling point of water;

- The vapor pressure of the COC components dramatically increases with temperature, as the subsurface is heated from ambient temperature to temperatures in the range of 100 ^{o}C;

- Adsorption coefficients are reduced moderately during heating, leading to an increased rate of desorption of COCs from the soil (Heron et. al., 1998); and

- The vapor pressure of the NAPL components dramatically increases with temperature. As the subsurface is heated from ambient temperature to temperatures in the range of 100 ^{o}C, the vapor pressure of the NAPL constituents will typically increase between 10 and 30-fold (Udell, 1996).

The COCs volatilized and steam stripped from the soils will be recovered via a network of vapor extraction wells and subsequently treated with a vapor and liquid treatment system. Fugitive emissions will be prevented by maintaining negative pressures at the wellheads and where possible across most of the target treatment zone (TTZ) through operation of a vapor extraction system. In addition, all vapor collection piping will be operated under a net negative pressure, so if there are any leaks contaminants will be contained within the piping. A backup electrical generator and transfer switch will be integrated into the system so that in the event of a loss of grid power, the vapor collection and treatment system continue to operate. If grid power is lost, no energy will be added to the subsurface until grid power has been restored. A conceptual schematic of a ISTR system is illustrated in Figure 6.

The most robust form of extraction for thermal systems is when a vacuum is applied along every heater or co-located with a heater well. An increase in soil permeability occurs when the immediate material around the heater dries out, and vapor flow towards the heater is enhanced. The increase in soil temperature and resulting enhancement of permeability in low yielding formations (clays and silts) allows vapor extraction to be effective in these types of soils. In addition, steam production from reaching boiling temperatures in the subsurface creates the necessary pore volume sweep and creates steam flow in the direction towards the heaters and co-located vapor extraction wells. Further literature on the effectiveness of vapor and steam extraction during thermal applications is published in a peer-reviewed journal (Heron et al. 2013).

This design assumes an energy balance will be maintained for the TTZ using the following data:

- Energy delivered by the TCH system heaters;
- Energy removed in the form of condensable vapor;
- Energy removed in non-condensable air; and
- Estimated heat losses.

The energy balance returns an average heating rate (in degrees per day) and an average TTZ temperature. These parameters are compared to the design values (energy delivery, average temperature) and the observed subsurface temperatures from thermocouple measurements. An energy balance will be periodically calculated for the Site to verify that the thermocouples are providing accurate representation of conditions throughout the TTZ and to assess the progress of heating as follows:

- The total energy delivered to the Site using the ISTR heaters will be derived from wellfield electricity usage. Power used for the process equipment (blowers, pumps, etc.), will be measured or estimated separately;

- The thermocouple data will be evaluated to provide detailed information on the heat-up of the subsurface. These data will be used to determine the amount of energy stored in the subsurface (e.g., energy stored in soil is equal to the soil temperature times the specific heat capacity of soil times the mass of soil; and

- Energy will be removed from the Site in the form of steam and vapors. The hot vapors from the vapor extraction wells will consist of steam and air. The energy fluxes are determined by multiplying the flow rate by a heat capacity by the fluid temperature. For steam, it is determined as a flow rate times the specific enthalpy of the steam (heat of condensation).

2.5.2 Target Treatment Zone

Based on the PDI results discussed in Section 2.2, the volume of impacted soil as calculated from the EVS model output is approximately 17,000 cubic yards. To offset heat losses, ISTR heater wells must extend at least 5 ft above and below the boundary of the impacted soil volume or target treatment zone (TTZ) with an additional 1 to 2 ft of room for thermal expansion at the bottom. Based on these considerations, for the target treatment volume of 17,000 cubic yards, the volume of soil to be targeted for TCH ("TCH TTZ") is 27,200 cubic yards. This is in part because the EVS model volume is irregular in shape, and the heaters are linear – meaning that a larger volume than the surgical volume needs to be heated to provide effective treatment. The TCH TTZ for OU3 Source Area A is depicted in Figure 7.

The derivation of the TCH TTZ and volume of soil to be heated is discussed in further detail in the Thermal Model Simulation Report contained in Appendix A. Note that further refinement of the TTZ remains to be completed to the east and north-east, and that additional soil borings within the Main Production Area of the building are planned to be performed when access to these areas is feasible during a scheduled shutdown of the Albéa Washington plant in December 2018. Once these additional results are obtained, a final refinement to the TTZ will be completed for incorporation into the Pre-Final (90%) Remedial Design Report.

The proposed locations of the supplemental soil borings planned to the north and east of PDI-SB25 and PDI-SB26 beneath the facility's MPA to determine the extent of the TCE soil impacts above the RG of 1 mg/kg are illustrated in Figure 7. The proposed supplemental soil boring locations are represented by the two ellipses shown on Figure 7, which correspond to the areas within the MPA where there is sufficient access for the drilling equipment and workers to safely conduct the work. To provide additional delineation of TCE impacts to soil east of the Former Molding Room up to four additional soil borings will installed and sampled (two borings per area). The drilling and sample collection methods utilized will be the same as those used for the previous PDI work as discussed in Appendix A of the P/TSE report. Initially, two soil borings will be vertically drilled and sampled approximately 50 feet west of existing borings PDI-SB25 and PDI-SB26 in the area depicted on Figure 7. Each boring will be sampled to a depth of approximately 122 feet bgs, or until competent bedrock is encountered, whichever is shallowest. The results of these two soil borings will be used to locate an additional boring at each location, either further east if the eastern edge of the impacted area has been not been reached, or if the eastern edge has been identified, the borings will be located west of new borings in the direction of PDI-SB25 or PDI-SB26 for refinement of the TTZ.

2.6 Attainment of Remedial Action Goals

To attain the goal of 1 mg/kg for TCE, the TTZ will be heated to temperatures between 87 and 100 ºC, with an operational target of reaching boiling temperatures at all locations inside the TTZ. Similar, or lower TCE concentrations, have been attained at multiple sites using the same ISTR technology and approach. Examples include the Teterboro Landing site in NJ, where stringent goals were reached for TCE in a more challenging setting (below the water table in a sandy silt formation). The Teterboro site along with other sites that were successful in attaining a RG goal of 1 mg/kg (or less) for TCE using TCH are presented on Table 1. Methods for demonstrating attainment of remedial goals are described in Section 8.

3. IN SITU THERMAL REMEDIATION SYSTEM DESIGN

3.1 General

This section presents the preliminary design of the ISTR system to thermally treat the impacted soils at the Site. Preliminary design drawings showing general arrangements of the system components including the existing site features/facility layout, TCH heater well layout, electrical one-line diagrams, mechanical layout and a process flow diagram are provided in Appendix B. A preliminary list of technical performance specifications to be prepared and submitted with the Pre-Final (90%) Remedial Design Report submittal is provided in Appendix C.

The OU3 Remedial Design/Remedial Action (RD/RA) is planned to be performed using a turn-key design-build approach for project delivery. Pursuant to the CD Section VI, paragraph 12.a, Ramboll has been identified by PPPI as its Supervising Contractor for OU3. Ramboll, as PPPI's designated Supervising Contractor, will perform both the RD and the RA. Components of the design-build delivery approach is summarized below.

3.2 Design-Build Delivery Approach

PPPI's approach for implementing the design and construction of the ISTR System is the "design-build" process. Design-build is a construction delivery method where an engineer/constructor provides both the design and construction management for a project, in contrast to the traditional design-bid-build approach. The remedial design for the ISTR System will be prepared consistent with the design-build approach in that site-specific, performance-based construction specifications will be developed and presented in the Pre-Final (90%) and Final (100%) Remedial Design deliverables sufficient to enable commencement of construction, while the design of certain elements, such as final piping and electrical cabling arrangements will be finalized as construction proceeds. In this manner the design-build approach will provide flexibility and facilitate delivery of the system while allowing full utilization of the expertise of vendors and subcontractors while coordinating the installation with Albéa, the Owner Settling Defendant. The level of detail incorporated in this Preliminary (30%) Remedial Design Report provides sufficient information (e.g., basis of design and supporting calculations to determine equipment sizing, dimensions, and placement) to ensure the performance of the system when installed at the Site. This method of delivery is consistent with that provided in guidance included in Engineering Guidance, Design Manual (Revision 8) (CEHNC 1110-1-1) (USACE, 2013).

3.3 ISTR System Overview and Layout

The ISTR system consists of TCH borings, each with co-located vapor extraction wells (VEWs) screened across the depth of the TTZ. Energy is delivered to the heaters, creating hot casings, and the volume heats by thermal conduction. As a vacuum is drawn on all the SVE wells, steam and vaporized TCE is conveyed to the surface equipment for treatment on-site.

In the former Molding Room area, heaters and vapor extraction screens will be installed using vertical or angled drilling. The part of the TTZ under this area will be remediated using vertical borings, with some angled under the building walls to access TCE slightly outside of the foot-print accessible by the rigs. To the east, the large TCE area will be remediated using angled heaters and extraction wells, arranged in "fans" of heaters. These are essentially groups of heaters and wells at different angles and set-backs placed so they cover a vertical section. Each fan is carefully laid out so the distance between adjacent heaters remain in the 15 to 20-foot range, ensuring that the soils between them can be adequately heated to reach the target temperature for soil treatment. Please note that all heaters will extend at least 5 ft outside the top and bottom of the TTZ. By applying heat at a minimum of 5 ft above and below the target zone, the heat losses towards the treatment zone boundaries are offset to ensure complete heating and contaminant reduction within the TCH TTZ. Heater borings will be installed with a co-located VEW to ensure capture of the volatilized steam and contaminants.

The wellfield layout for the Site utilizes a heater spacing of approximately 15 to 20 ft, varying with locations and depth depending on the installed/drilled angles, and based on practical limitations for installation. Drawing C102 in Appendix B shows the wellfield layout.

The major phases of the planned TCH operations are described below. Days in parentheses are the estimated durations of each operational phase. Please note that some phases may overlap based on observed temperatures and TCE mass removal rates and trends.

- Startup and establishment of pneumatic control (Days 0 to 5 of operation). Prior to startup, treatment system functional testing will be performed, and the operation of the system components will be verified. Following successful completion of functional testing, pneumatic control will be established prior to initiating heating.

- Initial heating (Days 5 to 65 of operation). During this phase, the TCH heaters are ramped up to their maximum power output.

- Continued TCH heating and approaching of temperature targets in the TTZ (Days 65 to 125 of operation).

- Final heating phase where vaporization is maximized by making adjustments to the ISTR system, with the objective of approaching diminishing returns with respect to removal of COCs (approximately days 125 to 185 of operation).

- Treatment completeness analysis phase (day 185 to 235 of operations). Treatment completeness is measured based on review of wellfield temperatures, total energy applied, wellfield vapor monitoring results, and other process parameters.

- Initial cool-down phase (Days 235 to 256 to of operations). During this phase, extraction continues at near maximum rates to provide initial cooling to the TTZ.

Additional detail and discussion of criteria for starting and completing each operational phase will be presented in the Operations, Monitoring and Maintenance (OM&M) Plan to be presented in the Pre-Final (90%) Remedial Design Report.

3.4 In Situ Thermal Desorption Modeling

In situ thermal desorption modeling was performed to estimate the operation duration and energy usage for meeting the remedial goals and objectives. This model was used to simulate the addition, removal, and loss of energy in each layer of the Site separately, with the layers exchanging both fluids (water and steam) and energy along their boundaries. The calculations estimate heat losses along the top, sides, and bottom of the TTZ, such that relatively accurate total energy demands are derived. The model also calculates average layer temperatures based on the energy balance and the estimated heat capacity of each layer. The model output includes the following items:

- Operational duration (days);
- Energy usage for heating (kWh);
- Peak power draw (kW);
- Temperature profiles over time;
- Water saturation over time; and
- Energy balance with rates and totals for steam extraction and water treatment needs.

The model derivation, assumptions, setup parameters, and output results based on the conducted water and energy balance is described in the Thermal Model Simulation Report included in Appendix A.

Based on preliminary modeling results performed for the TTZ, the total operational duration for the thermal remedy is estimated to be 256 days, including approximately 21 days of post-treatment vapor extraction and initial cool-down. The duration of heating is currently estimated at 235 days.

3.5 Geotechnical Considerations

When soils are subjected to expulsion of water or air from the void spaces, a volume reduction of the soil mass can occur resulting in settlement. For fine-grained soils such as clay and silt, the removal of water within the pore spaces as a result of thermal heating can cause consolidation to occur even after long periods of time after remediation is complete. In the case of the OU3 soils at the Site, since the depth of the TTZ is greater than 60 feet bgs and the residual moisture content of the soil within the TTZ is approximately 12%, no significant settlement is anticipated to occur due to thermal heating. To further evaluate the potential for settlement, a geotechnical evaluation will be conducted and presented in the Pre-Final (90%) Remedial Design Report.

3.6 Thermal Conductive Heater and Vapor Extraction Wells

Based on experience gained through the PDI soil boring program at the Site, the drilling method for the vertical and angled soil borings for TCH installation will be roto-sonic to ensure accurate well placement, minimize impact of potential obstructions, and minimize the volume of drill cuttings generated.

Vertical Heater Well Borings with Co-located VEWs: The heater wells supply heat by thermal conduction to the subsurface for all treatment areas that are immediately below the building. The heater borings will extend 5 ft beyond the top and bottom of the treatment area. A sand pack installed around the boring will allow migration of vapors into the co-located vapor extraction screen installed across the depth of the treatment zone. The upper portion of the well will be grouted to provide a seal around the well and prevent vapors from migrating above the contaminated zone.

Angled Heater Well Borings with Co-located VEWs: These wells supply heat by thermal conduction to the subsurface within the treatment zone below the building, but outside the foot-print of drill-rig access. These wells will be installed at angles between 38 and 85 degrees from horizontal to adequately heat the contaminated area below the building and beyond the walls and subsurface of the former Molding Room Area. Angled heater borings will be installed with the same specifications and backfill as the vertical heaters.

3.7 Temperature Monitoring Points

The temperature monitoring points (TMPs) will be instrumented with thermocouples approximately every 5 ft in the vertical interval from the surface to the bottom of the TTZ to enable monitoring of heating progress. The TMPs will be installed within steel casings and constructed in a vertical position. Some steel casings were installed within some of the soil borings performed during the PDI activities, and these are planned to be included as TMPs to receive installation of thermocouples for monitoring of the OU3 RA.

3.8 Process Treatment System

The treatment system will consist of carbon-based vapor and liquid treatment systems. The liquid discharge streams will be treated through granular activated carbon prior and containerized for transport and discharge to the existing GWETS. Vapors will be treated with vapor-phase granular activated carbon prior to discharge to an emissions stack under an NJDEP air permit to operate for which application will be made during the Pre-Final (90%) Remedial Design. Drawing P-101 in Appendix B shows the process flow diagram for the ISTR system. The design basis for the process treatment system components (e.g., vapor and liquid process flows, TCE mass removal rates, condensate volume, etc.) will be presented in the Pre-Final (90%) Design.

3.9 Vapor Treatment System

The vapor extraction and treatment system will consist of the following major components as shown on Drawing P101:

- Condensate knockout tank
- Vapor Heat Exchanger
- Moisture Separator
- Process Blowers
- Vapor Phase Carbon Vessels
- Chiller

- Exhaust stack

The liquid treatment system will consist of the following major components as shown on Drawing P101:

- Bag Filters
- Liquid Phase Carbon Vessels
- Temporary Effluent Holding Tank

Additional information regarding the major system components is presented below. It is important to note that specific equipment may change due to design modifications and equipment availability.

3.9.1 Vapor Conveyance Piping

With the temporary nature of the thermal treatment system, the operational wells are constructed as aboveground completions for ease of operation and maintenance. Vapor manifold piping will be installed on the floor of the building and/or supported on uni-strut (or similar) pipe stands within the former Molding Room area. The vapor manifold lines will then run overhead and exit the siding of the building to the process vapor equipment for treatment. Vapor piping will consist of fiberglass pipe. Connections to the individual wells will be made with temperature and chemical rated hose connections to allow sufficient flexibility for thermal expansion during operation.

3.9.2 Condensate Knockout Tank

After exiting the wellfield, the process vapor stream will be drawn through a condensate knockout tank to remove condensate or entrained liquids. The liquids collected are pumped to through bag filters and to the liquid treatment equipment.

3.9.3 Heat Exchanger

After passing through the condensate knockout tank (S-101), the vapors are processed in heat exchangers to cool and condense the incoming steam and reduce the moisture content of the vapor stream for the remaining steps in the process. The vapors entering the heat exchanger are cooled using a recirculating loop of water supplied by a chiller. The heat exchanger and chiller are designed to sufficiently reduce the temperature of the vapor stream to the point where the bulk of the moisture is removed from the wellfield vapors and minimal contaminants are removed via condensation.

3.9.4 Moisture Separator

Following the heat exchanger, the cooled vapor stream and generated condensate will be drawn through a secondary moisture separator to remove free liquids and entrained liquid droplets. Liquid collected in the tank will be combined with the condensate sump stream and pumped through bag filters to the liquid treatment equipment.

3.9.5 Vapor Phase Carbon Treatment

For this Preliminary (30%) Remedial Design and treatment system sizing, a conservative TCE mass of 500 pounds (lbs) has been assumed to be present within the TTZ. On this basis, a vapor-phase granular activated carbon (VGAC) system has been selected as the primary means of vapor treatment at the Site. Two vessels will be used in series to optimize mass loading, control the potential for breakthrough and minimize waste generation. The vapor stream will be cooled and condensed in the vapor treatment system to minimize VGAC usage.

3.9.6 Process Blowers

The process blowers will be duplex regenerative type. One blower will operate while the other will remain for standby use. The blower will supply the motive force (vacuum) needed to draw the vapors from the wellfield and through the vapor treatment system. The vacuum that will be applied to the wellfield is expected to be relatively low, in the range of 30-inches of water column (w.c.). The process blowers will include a variable frequency drive (VFD) to allow for speed adjustments.

3.9.7 Chiller System

A packaged chiller system will be used to provide non-contact chilled water for the vapor heat exchanger. The chiller will be a self-contained packaged rental unit.

3.10 Condensate Treatment and Discharge

Liquids will be cooled and routed to a bag filter prior to treatment with liquid-phase granular activated carbon (LGAC). Liquid will be stored in a temporary holding tank until the treated liquids can be manually transferred for discharge through the existing GWETS.

3.10.1 pH Neutralization

Although the prefabricated treatment system that will be provided includes the ability to inject caustic for pH adjustment of the condensate, it is not anticipated that such pH adjustment will be necessary in treatment of the soils of OU3 at the Site.

3.10.2 Bag Filter System

The liquid from the condensate sump and moisture separator will be pumped through a duplex bag filter assembly to remove any coarse particles before entering the LGAC vessels.

3.10.3 Liquid Phase Carbon

Filtered effluent from the bag filters will pass through two LGAC vessels in series. The two vessels are plumbed in series with flexible hoses to facilitate swapping the order of the vessels when carbon is changed out. Influent, mid-fluent, and effluent sampling ports are provided to monitor for breakthrough.

3.10.4 Effluent Tank

Treated water will be temporarily stored in an effluent tank until the treated liquids can be manually transferred for discharge through the existing GWETS.

3.11 Electrical Power Distribution System

The ISTR contractor and licensed electrician will run secondary conductors from breakers off the main switchboard to downstream panel boards that feed the heater and process equipment as shown on the Electrical Single Line Drawing (E101 in Appendix B). Due to the temporary nature of the project, the majority of the equipment connections will be made using extra heavy duty rated portable power cords (e.g., Type W cord, Type G cord, “mining cable”) and other portable cords (e.g., Type SOW) suited for outdoor use in wet environments. All equipment will be installed, wired, and commissioned in accordance with the National Electrical Code.

The electrical power distribution system consists of the following major components:

- Primary Switchboard rated at 480Y/277V, 3 phase, 4 wire, 65kAIC;
- Secondary Switchboard 480Y/277V, 3 Phase, 4 Wire, 65kAIC for power feed to process loads; and
- Locally mounted and wired 112.5kVA 480-208/120V three phase transformer and 240/120V load center. The panel will be used to supply power for controls and auxiliary components such as panel heaters, heat trace, GFCI convenience receptacles, etc.

3.12 Auxiliary Power Supply

Backup power to operate the above-ground treatment system components is currently planned via an automatic transfer switch utilizing a rented diesel-powered generator. This auxiliary power supply will be sized to provide power the maintain operation of the process treatment system components such that steam, and soil vapor continues to be extracted from the heated soil volume to prevent migration beyond the treatment zone. A battery backup will maintain the main PLC in the event of a power interruption. No backup power to operate the heaters is planned.

3.13 Process Safety Design

3.13.1 System Alarms and Response Procedures

The programmable logic controller (PLC) will monitor and record selected system operating data including relevant temperatures, pressures and flows through the aboveground vapor treatment equipment, as well as the position of safety sensors and controls (e.g., pressure switches, level switches, and motor operated valves). The PLC will be accessible remotely through a wireless internet connection, allowing personnel to remotely access the PLC and observe the same operating information available to the field staff. If monitoring data exceeds pre-established normal operating ranges, the system operator will be notified via visual display elements on the control screen. If the system is shut down due to an alarm condition, the system operator and project personnel will receive notifications via cell phone or e-mail. Alarms and unplanned shut-downs will lead to notification of the system operators who will respond to the alarm and communicate with the operations and/or engineering staff to determine appropriate actions. Further details regarding system alarm and response actions will be presented in the OM&M plan in the Pre-Final (90%) Design Report.

3.13.2 Power Failures

Upon a loss of grid power to the entire system, the PLC, which is on a battery backup, will send an alert notification to the system operator. The alert will indicate power to the system has been interrupted and that a manual restart of certain systems will be required. The system operator will mobilize to the site to restart the system.

3.14 Compliance with USEPAs Clean and Green Policy

With respect to USEPA Region 2 Clean & Green Policy, the table below provides a summary of the factors considered for this project.

Topic from Policy	Relevance/Action to be Taken for this Project
Protect human health and the environment by achieving remedial action goals	TCH has been chosen as the preferred technology for ISTR at the site. TCH is a technology that is well documented and

	proven to be able to meet the TCE soil standard of 1 mg/kg- in contrast to many other technologies which struggle in vadose zone environments with heterogeneity and low permeability.
Support human and ecological use and reuse of remediated land	By achieving a high degree of certainty for remedial success, future use of the land is ensured.
Minimize impacts to water quality and water resources	The heating technology selected uses a minimum of water – no water is needed for injection, and therefore liquid extraction is avoided. In addition, the effluent treatment system will use a minimum amount of water by not involving vapor treatment systems that require acid gas scrubbing.
Reduce air emissions and greenhouse gas production	Vapor emissions are minimized and controlled using state-of-the-art condensing and adsorption systems. The heaters are powered by electricity, and therefore this energy demand and associated emissions are controlled by the electrical grid suppliers.
Minimize material use and waste production	A waste recycling program will be implemented that aims on maximum reuse of materials, such as stainless steel and nickel heaters, which can be re-used many times over.
Conserve natural resources and energy	A data management system and decision-making process will be employed to ensure that only the necessary resources are used, and that the thermal treatment is terminated once the remedial objectives have been demonstrated to have been met.
100% use of renewable energy, and energy conservation and efficiency approaches including EnergyStar equipment	See the comment above regarding energy supply – the system relies on grid power and is subject to the limitations of what is provided locally.
Cleaner fuels and clean diesel technologies and strategies	Construction activities will aim to reduce fuel consumption and the negative impacts it can have on people and the environment. One major effort includes the geographic consolidation of operating facilities to enable a more centralized approached to fleet maintenance and dispatch.
Water conservation and efficiency approaches including WaterSense products	As stated above, the TCH technology uses very little water, because it relies on thermal conduction.
Sustainable site design	As an example of activities described in Lemming et al (2013), sustainable options for the OU3 ISTR design will be selected if feasible.
Industrial material reuse or recycling within regulatory requirements	Recycling will be conducted during construction and system operation where practicable.
Recycling applications for materials generated at or removed from the site	As stated above, Recycling will be conducted during construction and system operation where practicable.
Environmentally Preferable Purchasing	Products will be selected based on preference for environmentally friendly products where practicable.

Greenhouse gas emission reduction technologies	As there are no direct technologies that reduce emissions, efforts will be undertaken to minimize the use of resources by having accurate designs and performance monitoring systems in place to ensure that the remedy is optimized and terminated once remedial goals have been met.

4. PERMITTING

4.1 Air Discharge

A preconstruction permit, certificate to operate, and permit for construction of a new source will be sought for discharge of treated vapors from the ISTR system at the Pre-Final (90%) Remedial Design stage. An application for modification to the existing PPPI air permit equivalency (PI No. 85714) will be prepared and added to the equivalency as a new source of emissions.

4.2 Condensate Discharge

The water discharge permits that are currently in place for the GWETS for OU1 (TCE) Groundwater will be reviewed to determine if modifications are necessary to treat and discharge the condensate through the GWETS as described below.

4.2.1 Discharge to Groundwater Permit Equivalency

As noted above, condensate from the ISTR system will be transferred to the existing GWETS. It is anticipated that this will be accomplished by tanker truck and discharged into the floor sump of the GWETS for subsequent treatment and discharge to the existing injection wells. The addition of treated condensate water to the system will warrant notification to the NJDEP for minor modifications and/or authorization to add this discharge to the GWETS's current DGW Permit-by-Rule Equivalency. This request for discharge authorization will be prepared at the Pre-final (90%) Design stage.

4.2.2 Water Allocation Permit Equivalency

The existing CERCLA Water Allocation Permit Equivalency issued by the NJDEP for the GWETS (EQP150001), OU1 (TCE Groundwater) will be updated, if necessary, to include treated condensate to be discharged to the aquifer via the GWETS injection wells. The modification will be requested as a minor modification in accordance with N.J.A.C. 7:19-1.5(b), as the addition of condensate water will neither result in the addition of a diversion source nor in an increase in the diversion capacity of the GWETS.

4.3 NJDEP Well Construction Permits

The application for new heater/vapor extraction wells and temperature monitoring points will be submitted to the NJDEP for approval by a licensed driller of installation Contractor. Copies of the well modification application and Well Permit will be provided along with a NJDEP Monitoring Well Certification Form B for each new well. Application will be made following submittal of the Final (100%) Remedial Design Report to USEPA.

4.4 Local Construction and Building Permits

The New Jersey Department of Community Affairs (NJDCA) will be notified of the proposed construction of the piping/headers/manifolds, cabling, power distribution equipment, and electrical service upgrades prior to implementing the work. Construction permit applications will be applied for by the ISTR contractor in accordance with local requirements.

In addition, permits will be sought as necessary from New Jersey Central Power and Light Company for temporary electrical service installation for the ISTR system.

5. REMEDIAL CONSTRUCTION

This section outlines the remedial construction approach for implementing the ISTR remedy at the Site.

5.1 Mobilization and Site Controls

Personnel, equipment, and materials necessary to complete the scope of work for OU3 will be mobilized. Mobilization tasks include:

- Supply and placement of an office trailer and related office equipment and supplies;
- Health and safety gear/supplies;
- Tool trailer;
- Storage trailer;
- Port-a-john/hand wash stations;
- Temporary power supply to the office trailer;
- High speed internet connection;
- Wellfield survey using a Leica surveying system; and,
- Notifying 811, prior to beginning drilling activities.

Prior to beginning operation, temporary fence and/or barricades will be installed around the perimeter of the treatment equipment areas.

5.2 Site Preparation and Installation of Underground ISTR System Components

After the necessary site preparation activities have been completed, the location and elevation of the planned thermal remediation wells will be surveyed and the locations of each will be marked accordingly.

5.3 Installation of Aboveground ISTR System Components

After completion of well installation, wellfield assembly activities will include the following:

- Installation of liners, heaters, and junction boxes at heater well;
- Installing power and ground cabling to the heater wells and termination of cabling to a network of silicon-controlled rectifier (SCR) controllers to manage/control heater output;
- Installation and wiring of thermocouples at all TMPs in the wellfield;
- Installation of wellhead piping, valves, and hoses to transfer collected vapors and liquids to the vapor and liquid collection header piping;

Installation of the vapor and liquid collection headers to convey wellfield vapors to the vapor-liquid treatment system.

5.4 Commissioning and Startup of ISTR System

The purpose of commissioning is to inspect, test and calibrate the ISTR system and all ancillary system components prior to start-up and operations. During commissioning, ISTR contractor will identify and correct “bugs” or deficiencies in the heating, extraction, monitoring and treatment equipment, to ensure a smooth transition to full, normal operation. The commissioning and shake-down phase will also help to familiarize system operators with the Site and the ISTR system as it is implemented at the Site, prior to drawing contaminated liquid and vapor from the wellfield. Additional details on the ISTR system startup and operation are discussed in Section 3.3 and in Section 7 below.

5.5 Construction Quality Assurance Project Plan

A construction quality assurance project plan (CQAPP) is provided in Appendix D. The purpose of the CQAPP is to ensure that construction of the remedy is in accordance with the approved Design Report. The CQAPP presents the construction quality assurance/quality control (QA/QC) procedures to be implemented during installation and implementation of thermal treatment system. The plan sets forth the quality control responsibilities, required submittals/ documentation and a listing of required inspections and testing.

6. WASTE MANAGEMENT

A waste management plan is provided in Appendix E. As described in the plan, coordination with the transportation contractor and disposal facility will be conducted by Ramboll in coordination with the Contractor. Ramboll will be responsible for preparing waste profiles for acceptance by the off-site disposal facility. The Contractor will be responsible for the waste transportation and off-site disposal of the waste streams in accordance with application regulations.

Wastes anticipated during the thermal treatment activities included construction debris, soil cuttings, decontamination rinseate, drilling water, condensate water and spent GAC. The OU3 treatment is not expected to generate hazardous wastes. Should a hazardous waste stream be generated, an addendum to this plan will be submitted to the USEPA.

7. OPERATIONS, MAINTENANCE AND MONITORING

This section discusses the ISTR system operations, maintenance and monitoring activities that are planned for the Site. An overview of the phases for ISTR operation are summarized below along with an estimate of the duration of each phase. Please note that some phases may overlap based on observed temperatures and TCE mass removal rates and trends.

- Startup and establishment of pneumatic control (Days 0 to 5 of operation).
- Initial heating (Days 5 to 65 of operation). During this phase, the TCH heaters are ramped up to their maximum power output.
- Continued TCH heating and approaching of temperature targets in the TTZ (Days 65 to 125 of operation).
- Final heating phase where vaporization is maximized by making adjustments to the ISTR system, with the objective of approaching diminishing returns with respect to removal of TCE (approximately day 125 to 185 operation).
- Treatment completeness analysis phase (day 185 to 235 of operations). Treatment completeness is measured based on review of wellfield temperatures, total energy injected, wellfield vapor monitoring results, and other process parameters.

- Initial cool-down phase (Days 235 to 256 to of operations). During this phase, extraction continues at near maximum rates to provide initial cooling to the TTZ.

Additional detail and discussion of activities to be conducted during each operational phase is described below.

7.1 ISTR System Startup

Once construction activities are complete, a kick-off meeting and operational readiness review will be held at the Site. In this kick-off meeting the system commissioning, startup and operational activities to be performed will be presented.

Commissioning activities to be performed before system start-up are presented on the Preliminary TCH System Commissioning checklists provided in Appendix F. The commissioning (start-up/shakedown) period is expected to take approximately 1 week. The purpose of the commissioning phase is to inspect, test, and calibrate the ISTR system, including materials and equipment in the wellfield and the process treatment equipment. This phase is intended to identify and correct bugs or deficiencies in the system prior to full system operation. Clean (non-potable) water and air will be used to perform functional testing of the system. A general summary of the commissioning tasks is presented below:

- Verify wellfield thermocouple signals;
- Check all motors for proper rotation;
- Verify and calibrate all instrument signals;
- Verify proper function of all local control panels;
- Verify all analog and discrete input/output signals to/from the programmable logic controller (PLC);
- Test all alarm and interlock functions;
- Test alarm dial-out/SMS function;
- Pressure and leak test vapor and liquid transfer lines;
- Verify proper operation and function of vapor/liquid treatment system components;
- Set all valves to the proper pre-start positions;
- Pre-fill liquid tanks and vessels to the pre-start levels;
- Flood, backwash and de-aerate liquid carbon beds;
- Fill tanks, cooling tower sump, and heat exchangers and verify coolant circulation; and,
- Confirm that all findings/recommendations from the TCH System commissioning activities have been properly addressed prior to startup.

During the startup phase, pneumatic control will be established with operation of the vacuum extraction system and by monitoring vapors from the vapor extraction wells. Performance of the process treatment system for separation and treatment of vapors and liquids will be verified by process monitoring and sampling. Monitoring and sampling to be conducted during startup is discussed in the following sections. Once it is documented that the treatment system meets the required criteria (flow rates and pressures) the TCH heaters will gradually be brought online.

7.2 ISTR System Operation and Monitoring

During ISTR system operations, monitoring and sampling will be conducted periodically and resulting data will be used to track remedial progress and optimize system performance. Details on the system monitoring activities to be performed are discussed below.

The heater operation will be controlled by the individual heater circuit Silicon Controlled Rectifiers and their individual temperature controllers. An operator will monitor the system throughout operation and adjust as needed. Adjustments to the system operation will be made in consultation with the ISTR Project Manager and Project Engineer. Potential adjustments that may be considered include the following:

- Adjust (increase/decrease) power input to the TTZ;
- Adjust vacuum applied to the wellfield; and,
- Adjust vapor extraction rates to limit energy removal from the subsurface or to increase flushing of the TTZ.

The programmable logic controller (PLC) will log selected system operating data including relevant temperatures, pressures, and flows through the vapor treatment equipment, as well as the position of safety sensors and controls (e.g., pressure switches, level switches, motor-operated valves). Wellfield temperature data from the TMPs will be collected and logged by a separate temperature data collection system. The PLC and temperature logging system will be accessible remotely through a dial up modem or high-speed internet connection, allowing personnel to access the PLC and observe the same operating information available to the field staff. Alarms and shut-down conditions will result in automatic notification of off-site operators by cell phone.

Operational staffing for the Site is anticipated to consist of a minimum of one (1) operator, who will be on-site approximately 8 – 10 hours per day, five (5) days per week, with brief visits on weekends to confirm operations. A local operator may be called upon to support operations during this time to inspect the system, collect operational data, and perform routine maintenance. More frequent visits may be necessary to respond to alarm conditions and re-start the system in order to maintain system uptime. Additional detail and specific criteria describing the operation, maintenance, and monitoring of the ISTR system will be presented in the Operations, Maintenance, and Monitoring (OM&M) Plan. A draft OM&M plan will be included in the Pre-Final (90%) Remedial Design Report submittal. A list of the contents of the draft OM&M Plan is provided in Appendix G.

In the event of a system shut down, the system operators will be notified immediately and will generally report to the Site within 30 minutes based on the nature of the alarm. Response times are expected to be no more two hours from the shutdown notification for the less urgent warning-level alarms. The system will not be restarted remotely and will not be restarted without the approval of ISTR Project Manager or designee.

A data management system will be used to provide real-time remote access to selected site data such as wellfield temperatures and selected process treatment system data (e.g. temperature, flow, and pressure and operational status at various points in the treatment system) to facility reporting of the system operation and treatment progress. The data management system will be operational once the ISTR operations commence.

The following system operational data will be available on the data management system and will be used for periodic performance monitoring and reporting:

- Average soil temperatures
- Energy balance (rates and totals)
- Water balance

- Vapor balance
- TCE mass removed
- Power usage

7.2.1 Subsurface Temperature Monitoring

Data from the TMPs will be used to evaluate heating progress. The data will be collected and stored on the data management system. Subsurface temperature monitoring will demonstrate that the target temperatures are achieved, such that TCE is rendered thermodynamically unstable and vaporized. Since TCE has a boiling point of 87ºC, this temperature will be an operational target. However, the majority of the TTZ is expected to heat to the boiling point of water (100ºC). At a minimum, the following subsurface temperature data representations will be prepared and evaluated:

- Individual TMP temperature profiles (i.e., temperature vs. depth);
- Plots of temperature versus time for all sensors; and,
- Average temperatures at different depths from top to bottom of the TTZ

7.2.2 Vapor Sampling

Extracted vapors from the ISTR system will be monitored to track progress of the remedy in terms of mass of TCE extracted from the subsurface and for compliance with air discharge permit requirements. Vapor samples will be periodically collected from the vapor extraction well heads and treatment system influent and effluent. A handheld 10.6 eV PID [MiniRae 3000 or similar) will be used to screen process vapor concentrations at various locations on a weekly basis. The specific process locations to be sampled are:

- At the influent to the treatment system;
- At intermediate locations in between treatment vessels, as appropriate;
- At the discharge location (effluent stack); and
- At individual vapor extraction wells.

Vapor samples used for screening measurements and field analysis using the PID will be collected in Tedlar™ bags. Vapor samples will be periodically collected from the vapor extraction well heads and treatment system influent and effluent using Summa canisters and analyzed at a fixed-base laboratory for VOCs using EPA Method TO-15 in accordance with the QAPP. These vapor samples will be used to provide further information of the TCE concentrations and mass extracted to evaluate the effectiveness of the TCH and vapor discharge treatment system. These samples will be collected on a bi-weekly basis beginning midway through the initial heating period (i.e., at ½ the optimum temperature target in the TTZ or approximately when the subsurface reaches 50 ºC) and will continue until the TCE mass extracted has peaked. When it is determined that the TCE mass extraction rate has peaked the frequency of the vapor sample collection will be reduced to a monthly schedule until system shutdown. In order to use the vapor concentration data for system optimization during the full-scale heating phase, an expedited sample analysis turnaround time of 3-days will be requested.

7.2.3 Condensate Treatment System Sampling

The condensate generated from the treatment system will be sampled for VOCs at pre-and post-treatment sampling ports located on the treatment system. The samples will be collected to verify the treatment efficiency of the liquid treatment system and for compliance with discharge permit requirements, if necessary. The frequency of the condensate sampling will be performed monthly during the period of system operation.

7.3 TCH System Maintenance

The ISTR contractor will be responsible for maintaining the ISTR system. Since it consists of electrical gear and has no moving parts, maintenance is minimal. Broken fuses, Silicon-Controlled Rectifiers, relays and similar electrical components will be replaced as needed, and spare parts will be kept on site. In the event a heater element fails during operation, the defective element will be removed from the heater well and a new element will be installed.

7.4 Vapor Intrusion Mitigation System Operation and Monitoring

The operation of the existing vapor intrusion mitigation system as described in Section 1.5 will be monitored to verify that the system remains effective during TCH operations. Monitoring of sub slab vacuum and indoor air will be conducted as discussed in the following subsections.

7.4.1 Sub-Slab Monitoring

During TCH operations, sub-slab vacuum and PID measurements will be collected from the existing vacuum monitoring points (VMPs) located inside the Albéa facility to verify that the vapor intrusion mitigation system remains effective in preventing soil vapors from migrating to indoor air. Vacuum and PID measurements will be collected at all VMPs weekly to confirm that negative pressures are present below the floor slab of the Albéa building and that sub slab vapor concentrations are not increasing as a result of the TCH operation. Vacuum readings and vapor concentration measurements will be performed at the VMPs using the methods and procedures described in the Operation, Maintenance, and Monitoring Plan for the vapor intrusion response activities, Albéa Americas, Washington Facility (Ramboll Environ, 2015b). In the event positive pressures or significant increases in vapors beneath the floor slab are detected, the sub-slab vapor mitigation system extraction point valves will be adjusted to increase air flow and/or vacuum. In addition, the vapor mitigation system blower flow rate and inlet vacuum may also be adjusted to increase subsurface vacuum and flow throughout the SSDS extraction well network. Should further increases in sub slab vacuum be necessary during TCH, operation of the auxiliary 100 cfm vapor mitigation system and/or west wall mitigation system blowers will also be considered.

7.4.2 Indoor Air Monitoring

To verify that the safety and health of workers inside the Albéa facility remain protected from potential vapor migration during operation of the ISTR system, the existing vapor mitigation systems located within the Albéa building will continue to be operated and monitored as a requirement of the remedy. To further document that indoor air remains below the established to-be-considered indoor air quality standard of 7 µg/m3 for TCE, a program to monitor the existing vapor mitigation systems for indications of impacts and to directly monitor indoor air quality on a real-time basis from several locations inside the Albéa facility during TCH operations will be performed. This indoor air monitoring program will be conducted utilizing a Gas Chromatograph (GC) with an Electron Capture Detector (ECD) configured for multipoint TCE sample collection and real-time analysis and response controls integrated into a web-based dashboard provided by Groundswell Technologies. The system is capable of sampling from 10 to 30 locations with automated analyses and detection limits of less than 1 µg/m^3 TCE.

The equipment will be designed to monitor and report indoor air quality conditions and sub-slab vapor concentrations so that adjustments can be made prior to initiating a stop work condition.

The monitoring system will be integrated into the ISTR system controls to initiate an alarm condition or to automatically alert the system operator should an exceedance of the air quality standard or significant increases in sub-slab vapor concentrations be detected. Examples of these controls include:

- Automated email or text messaging to designated personnel; and
- Automated triggering of engineering controls to actively mitigate the alarm condition (e.g., increase air exchange rate of vapor recovery system, adjust SSD system flows and vacuum, etc.).

This air monitoring, alarm and control system will add confidence that indoor air issues at the Site are continuously monitored and controlled in real time so that the existing operations within the facility will not be impacted. Periodic communication with Albéa personnel to provide status updates regarding indoor air monitoring data, vapor mitigation system operations, and any related safety or health protocols and system performance issues will also be performed as part of the indoor air monitoring program.

7.5 System Operations Reporting

System operations will be evaluated and reviewed weekly and any recommendations deemed necessary to improve the effectiveness of the remedial system (i.e., modifications to the energy input balance, adjustment in vapor extraction system flow rates, process treatment system modifications, etc.) will be communicated to the USEPA in conference calls as necessary. The information gathered from the above tasks for evaluating remedial progress and system performance will be documented in quarterly O&M reports and submitted to the USEPA. The effectiveness of the ISTR system in achieving the design objectives will also be reviewed and summarized in the quarterly O&M reports.

In general, the quarterly O&M reports will include the following:

- Brief descriptions of maintenance activities and/or adjustments to the system;
- Results from vapor samples collected during the period of operation;
- Systems operational data including average TTZ temperatures, simplified energy balance, estimates of TCE mass removed to date, volume of condensate generated/discharged, and performance of the process effluent treatment systems;
- Performance of the vapor intrusion mitigation system; and
- Results from the indoor air quality monitoring system.

The quarterly O&M reports will be submitted following receipt and validation of vapor samples submitted for laboratory analysis during the operational reporting period.

8. POST-REMEDIATION PERFORMANCE VERIFICATION PLAN

The effectiveness of the TCH process in achieving the remedial goal of 1 mg/kg TCE will be evaluated using a multiple lines of evidence approach. During implementation of the TCH remedy, several metrics will be considered for gauging progress and determining when the remedy is near or at completion. These metrics include: diminishing returns in extracted TCE vapor concentrations, attainment of design subsurface temperatures, and comparing the actual amount of energy applied to the TTZ versus the design input energy. This multiple-lines-of evidence approach is consistent with guidance presented in the Engineer Manual on In Situ Thermal Remediation (USACE, 2014) for determining ISTR remedy performance and attainment of RGs. Given that access to the former Molding Room area will be extremely limited due the density of the TCH heater borings and VEWs with extraction piping and electrical conduit, mobilization of a drill rig to conduct soil borings to perform confirmation sampling is not considered practicable. Further, it is noted that such sampling would need to be performed while the TTZ is still hot, presenting unnecessary health and safety risks including handling of hot drill casings, hot soil cuttings, and potential release of steam and fugitive emissions from the bore hole that could result in exposure to drilling crews and Albéa plant personnel.

Using TCH technology, adequate soil treatment can be sufficiently demonstrated through these lines of evidence. The methods in which these lines will be evaluated are discussed in further detail below.

8.1 TCE Vapor Sampling

As discussed in Section 7.2.2, extracted vapors from the ISTR system will be monitored to track progress of the remedy in terms of mass of TCE extracted from the subsurface. Vapor samples will be periodically collected from the vapor extraction well heads and treatment system influent and effluent using a PID, and Summa canister samples will be analyzed at a fixed-base laboratory for VOCs using EPA Method TO-15. The TCE vapor sampling will be conducted throughout the ISTR system operation and until system shutdown.

Towards the end of the heating period the daily TCE mass removal is expected to diminish, indicating that the TTZ has been depleted. Based on the current TCE mass assumption of 500 lbs of TCE, an average of 2 lbs/day is expected to be removed during the 265-day operational period. Towards completion of the heating period, this removal rate is expected to drop below 0.5 lbs/day. Near the completion of treatment, typical TCE concentrations measured at the individual vapor extraction well heads using a PID are expected to be below 10 parts per million by volume (ppm_v), with peak readings typically more than 1,000 ppm_v during the peak mass removal period. The TCE vapor sampling results from the vapor extraction wells will be used to demonstrate these concentration reduction trends and that the TCE mass removal rate has reached an asymptotic level.

8.2 Subsurface Temperature

Monitoring of subsurface temperatures and sampling of extracted vapors will be performed during ISTR system operation to track the progress of the remediation, to optimize TCH operations, manage waste streams, and to verify that design temperatures have been reached to effect contaminant vaporization. Data from the thermocouples will be evaluated on a point-by-point basis to determine that the minimum design temperature of 87 ^{O}C has been achieved throughout the TTZ.

To demonstrate that the minimum design temperature of 87 ^{O}C has been reached throughout the TTZ, the target temperature readings at the thermocouples inside the TTZ 87 ^{O}C or higher in at least 95% of the thermocouples located inside the TTZ. This operational goal, that if reached and sustained in the majority of thermocouples will result in attainment of the RG of 1 ug/kg TCE in soil.

8.3 Input Energy

The input energy applied at the ISTR heater wells to reach the design temperatures within the TTZ, will be compared against the calculated design values presented in the thermal modeling simulations. This performance data will be used to verify that the amount of energy required to reach the design temperature has been applied to the TTZ for completion of the thermal remedy.

8.4 Performance Verification Report

Following successful demonstration that the multiple-lines-of evidence data indicate that *de minimis* concentrations of TCE in subsurface soils have been reached, a petition to shut the system down will be presented to the USEPA and a draft Performance Verification Report will be prepared and submitted to USEPA for approval. The report will document the results of the ISTR system monitoring and multiple lines of evidence that support demonstration of achievement of the RG.

Once the TCH heater wells have been turned off, the extraction and process treatment systems will continue to extract and treat vapors to allow for partial cool down and to capture steam and vapors still present in the subsurface. During this phase, the vapor and liquid treatment systems will continue to operate, and the subsurface temperature and pressure monitoring will continue. This phase is expected to last approximately 21 days.

8.5 System Decommissioning

Once it is determined that the RG has been achieved and the draft Performance Verification Report is approved by USEPA, the ISTR system will be decommissioned. This phase includes decommissioning of the wellfield, the process equipment, and interconnecting piping and hardware. Wellheads, meter runs, cables, and monitoring hardware will be removed from each well. TCH/VEW and TMP boreholes will be abandon in accordance with NJDEP requirements.

Interconnecting piping and treatment components will be broken down and decontaminated. Waste and scrap materials will be loaded into dumpsters for off-site disposal or recycling. Equipment will be cleaned and packed for return shipment by the ISTR contractor. Rented equipment and temporary facilities will be cleaned and demobilized from the Site.

8.6 Post Remediation Groundwater and Indoor Air Monitoring

It is proposed to conduct groundwater monitoring of the OU3 RA through incorporation of newly installed shallow groundwater monitoring well POHMW49 and converted well POHMW12R as part of the ongoing groundwater monitoring program being conducted for OU1 (TCE) to evaluate the performance of the GWETS and the Monitored Natural Attenuation remedy at the Site. As part of this ongoing groundwater monitoring program, the data collected will be used to evaluate the long-term performance of the OU3 remedy in meeting the remedial objectives. The current groundwater monitoring program, including details of well locations, parameters, and sampling/measurement frequency of monitoring for each element of the GWETS monitoring program are presented in the Groundwater Extraction and Treatment System Operation, Maintenance and Monitoring (OM&M) Plan (Ramboll, 2017a) and the MNA Work Plan (Ramboll, 2017b).

After verification that the RG has been attained for soils and the draft Performance Verification Report approved by USEPA, the vapor intrusion mitigation systems for the VIRA action inside the Albéa building will be shut down. After approximately 1 to 2 weeks following shut-down, one round of sub-slab vapor and indoor air samples will be collected to determine if the VIRA activities can be discontinued or if vapors are still present above levels that warrant continued operation of the vapor mitigation system and/or further monitoring of sub-slab vapor or indoor air. Indoor air samples will be collected at the following seven locations in accordance with the Operation, Maintenance, and Monitoring Plan for Vapor Intrusion Response Activities (Ramboll Environ, 2017).

- Former Molding Area
- EHS Manager's Office
- S Central Cafeteria
- EHS Coordinator's Office
- 2nd Floor Sales Office
- Main Production Area between VP-14 and VP-15
- 2nd Floor Conference Room

In addition, ten sub-slab vapor samples will be collected from the following sub-slab vapor monitoring points.

- CDM-SS-01
- CDM-SS-02
- CDM-SS-03
- EPA-SS-22
- EPA-SS-30
- EPA-SS-31
- EPA-SS-32
- VP-3
- VP-7
- VP-15

The locations of these indoor areas and sub-slab vapor monitoring points are shown on Figure 4. The samples will be collected in accordance with the QAPP and analyzed for VOC using EPA Method TO-15. Based on the sample results, a recommendation will be made on whether the vapor intrusion response activities should be discontinued or if continued operation of the vapor mitigation system and/or additional monitoring of sub-slab vapor or indoor air is necessary.

9. HEALTH AND SAFETY

A Site-specific Health and Safety Plan (HASP) for the project will be prepared to include the thermal treatment construction and OM&M activities. The HASP will be included as part of the Pre-Final (90%) Design Report in accordance with the SOW for the OU3 RA. The Contractor will also prepare their own HASP to address worker health and safety during installation, startup and operation of the ISTR system.

In addition, for this project, Ramboll, the Contractor and all subcontractors will follow Rio Tinto's corporate health and safety systems which area based on risk elimination and reduction. Ramboll will have a Site Safety Officer on-site during ISTR system construction, initial start-up, operation, and system decommissioning to maintain the standards set forth by Rio Tinto and Ramboll.

10. INSTITUTIONAL CONTROL IMPLEMENTATION AND ASSURANCE PLAN

The former ANC property is an active industrial facility and is expected to remain zoned for industrial use. An existing Deed Notice for the property which identifies a restriction of groundwater use (2015 Deed Notice) and restrictions of land use in areas deemed necessary for remediation activities, as well as areas that would interfere with the protectiveness of the selected remedy was recorded on April 9, 2015 (2015 Deed Notice). In accordance with the 2015 Deed Notice, PPPI was required to record a Supplemental Deed Notice with detailed exhibits on contaminants detected in soils groundwater and indoor air on the property. A Supplemental Deed Notice was prepared by PPPI and following review with Albéa these materials were submitted to USEPA for review in June 2018

The 2015 Deed Notice and Supplemental Deed Notice will remain in effect and will be amended to reflect the components of the OU3 remedy, as appropriate.

10.1 Proposed Modifications to Existing Institutional Controls

As discussed above, the former ANC property has an existing 2015 Deed Notice that restricts groundwater use and land use where the selected remedy is to occur. This 2015 Deed Notice and the materials prepared for the Supplemental Deed Notice will prevent human exposure to residual soil and/or groundwater contamination that may remain during and/or after completion of the OU3 RA.

10.2 Institutional Control Boundaries

Maps of locations of current impacts to soil, groundwater and indoor airs are included in the materials prepared in the Supplemental Deed Notice. Following completion of the OU3 RA, the materials included in the 2015 Deed Notice and Supplemental Deed Notice will be updated and recorded.

11. TIME SCHEDULE

Based on the current projected TTZ of 17,000 cubic yards presented in this Preliminary (30%) Remedial Design Report, an updated RD/RA time schedule for OU3 is provided in Figure 8.

12. REFERENCES

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USEPA. 2016b. Record of Decision, Pohatcong Valley Groundwater Contamination Superfund Site Operable Unit 3, Washington Borough and Washington Township, Warren County, New Jersey. September.

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Pechiney Plastic Packaging, Inc., (PPPI), 09-cv-5692 and United States v. Bristol-Myers Squibb Co., et al., 13-cv- 5798. June.

TABLES

Table 1
Examples of Remedial Goal Attainment Using TCH at Similar Sites
Pohatcong Valley Groundwater Contamination Superfund Site -Operable Unit 3
Warren County, New Jersey

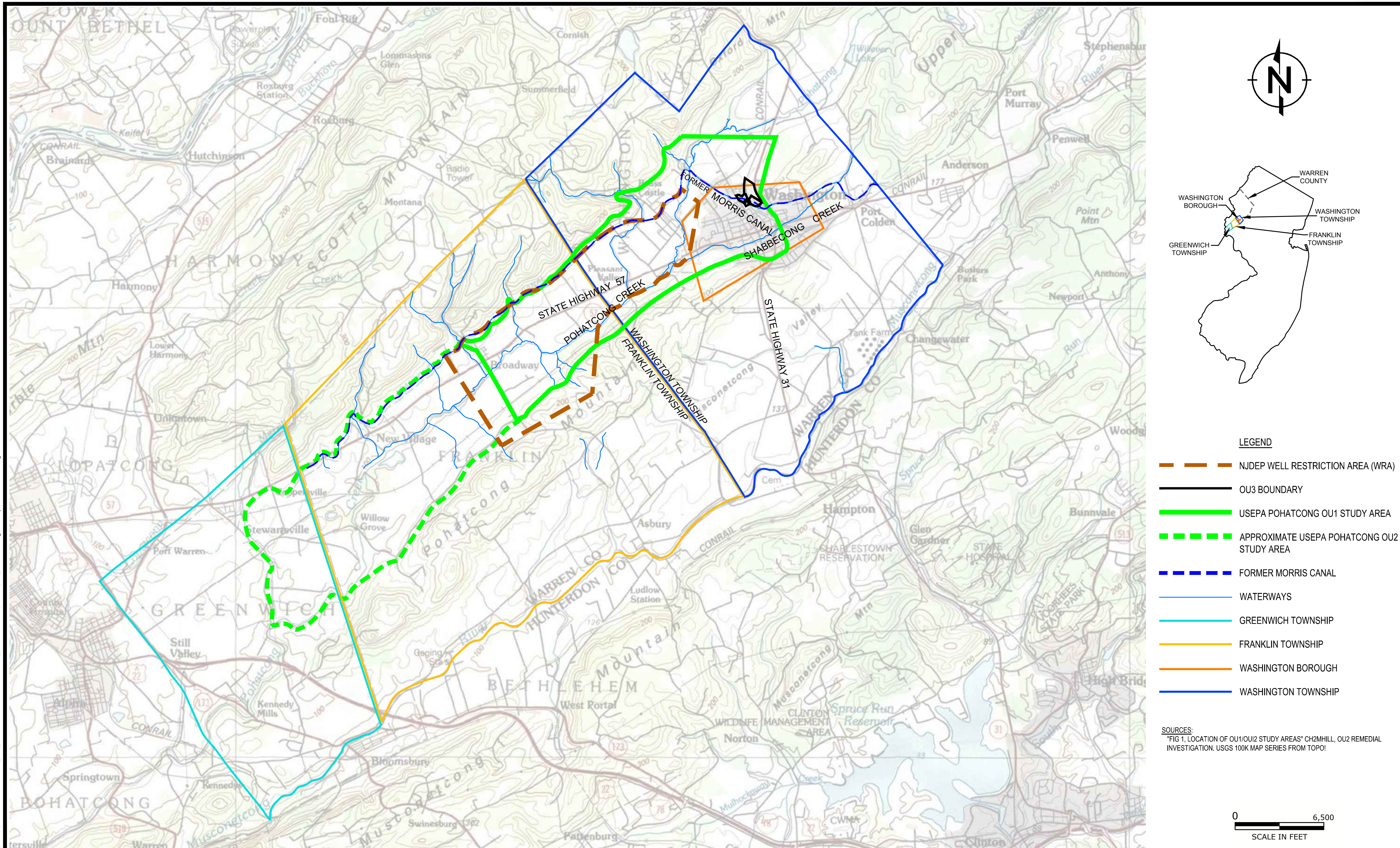
Site Name	Location	Major COC [1]	Mean Pretreatment Concentration	Remedial Goal	Mean Post-treatment Concentration
			mg/kg	mg/kg	mg/kg
Confidential Midwest Site	Midwest	TCE	99.7 (DNAPL likely present)	1.0	0.070
Terminal One	Richmond, CA	PCE, TCE	34.2 (DNAPL present)	2.0	0.012
Confidential SE Site	Southeast	TCE	13,800 (DNAPL)	In Vadose Zone: 0.060; In GW: Reduction in source concentration	0.017
Pioneer Midler Ave.	Syracuse, NY	PCE, TCE	2,864 (DNAPL present)	5.6	3.8
NASA Marshall Space Flight Center	Huntsville, AL	TCE	47.65 (max conc./history indicate DNAPL likely present)	1.0	0.060
Knullen	Odense, Denmark	PCE and DCE	340 (History indicates DNAPL likely present)	5.0	0.51
Memphis Depot, U.S. Defense Logistics Agency	Memphis, TN	CVOC	73 (max conc./history indicate DNAPL likely present)	0.34	0.045
Vadsbyvej	Vadsbyvej, Denmark	PCE, TCE, DCE, VC	NA	Reduction in source concentration in soil	met client's objectives
Groveland Wells Superfund Site	Groveland, MA	TCE	52 ppm (max TCE pre-treatment concentration)	Reduction in source concentration in soil and GW	met client's objectives
Michoud Assembly Facility	New Orleans, LA	PCE, TCE	NA	PCE: 0.12 TCE: 1	met client's objectives
Teterboro Landing	Teterboro, NJ	PCE	PCE: 7,230	1.0 for each COC	PCE: 0.056
SRSNE Superfund	Southington, CT	PCE, TCE and other VOCs	500,000 lb VOCs	NAPL elimination	99.7% reduction in soil
Confidential California Site	Bay Area, CA	CVOCs	Up to 49,000 µg/L (average 10,356 µg/L)	Minimum 90% groundwater concentration reduction.	Achieved 93% decrease in concentration (to 696 ug/L)

Notes:

mg/kg - milligrams per kilogram
ug/L - microgram per liter
DNAPL - Dense non-aqueous phase liquid
NAPL - Non-aqueous phase liquid
COC - contaminant of concern
GW - Groundwater
CVOC - chlorinated volatile organic compounds
DCE - Dichloroethene
PCE - Tetrachlorethene
TCE - Trichloroethene
VC - Vinyl Chloride
VOC - volatile organic compounds

[1] Although PCE is not a contaminant of concern at the site, PCE and TCE have similar physical behaviors such as 1) TCE boils at 87 C and PCE at 121 C; 2) TCE solubility is 1,100 mg/l and the solubility of PCE is 140 mg/L; 3) neither of these chemicals hydrolyze; and 4) both can only be removed by vaporization at realistic time-scales. As such, PCE is less volatile than TCE, and is therefore more difficult to treat than TCE. Because of this, case studies for both contaminants have been included to demonstrate the success of TCH to treat TCE (and even the slightly more recalcitrant PCE) under a wide range of site conditions.

FIGURES



RAMBOLL

DRAFTED BY: ELS | DATE: 8/28/18

LOCATION OF POHATCONG VALLEY GROUNDWATER CONTAMINATION SITE

POHATCONG VALLEY GROUNDWATER CONTAMINATION SUPERFUND SITE
OPERABLE UNIT (OU) 3
WARREN COUNTY, NEW JERSEY

FIGURE
1

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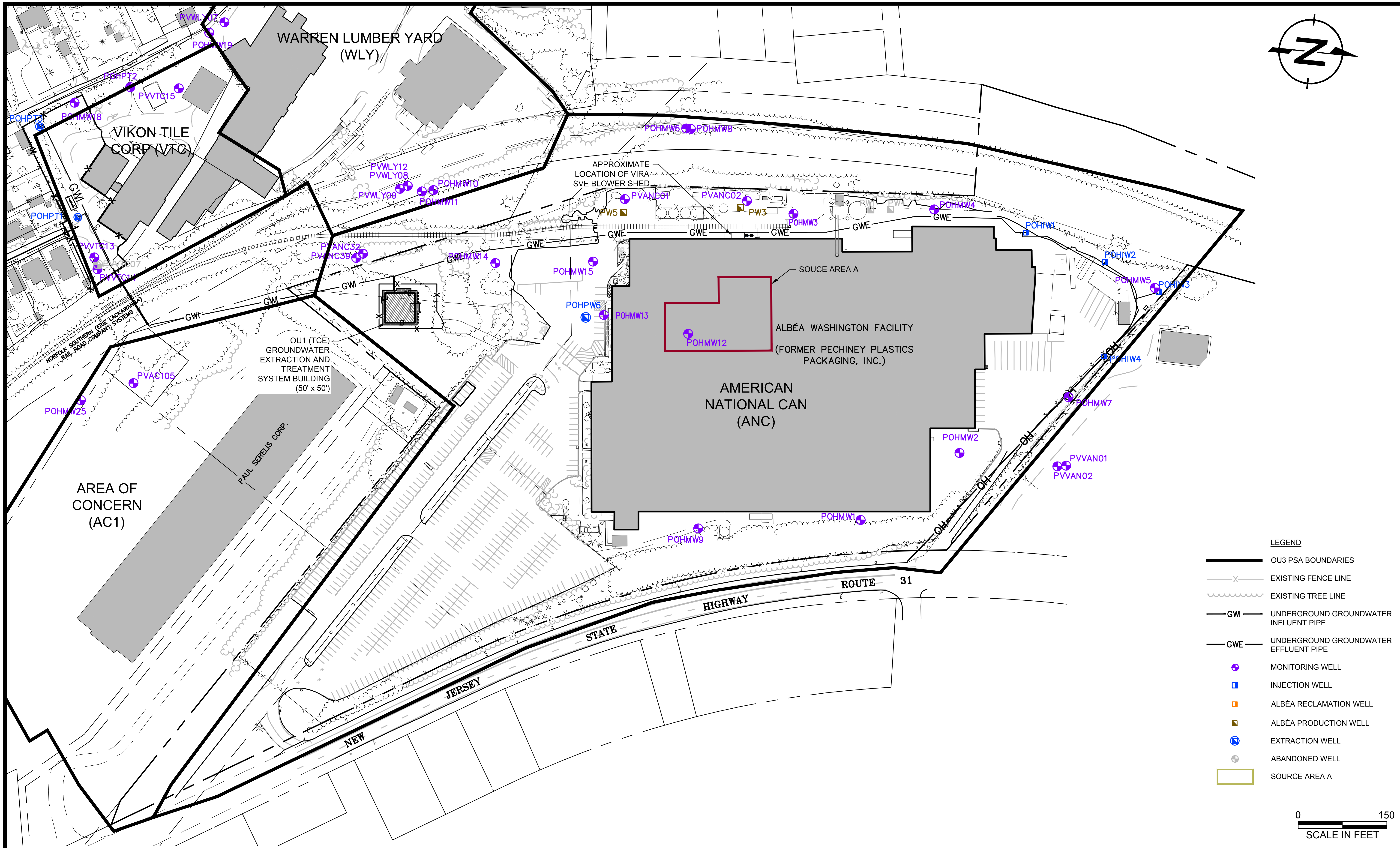

RAMBOLL

DRAFTED BY: MSB/PRM/ELS

DATE: 3/21/18

LOCATION OF OPERABLE UNIT 3 (OU)

POHATCONG VALLEY GROUNDWATER CONTAMINATION SUPERFUND SITE

OPERABLE UNIT (OU)

WARREN COUNTY, NEW JERSEY

FIGURE

2

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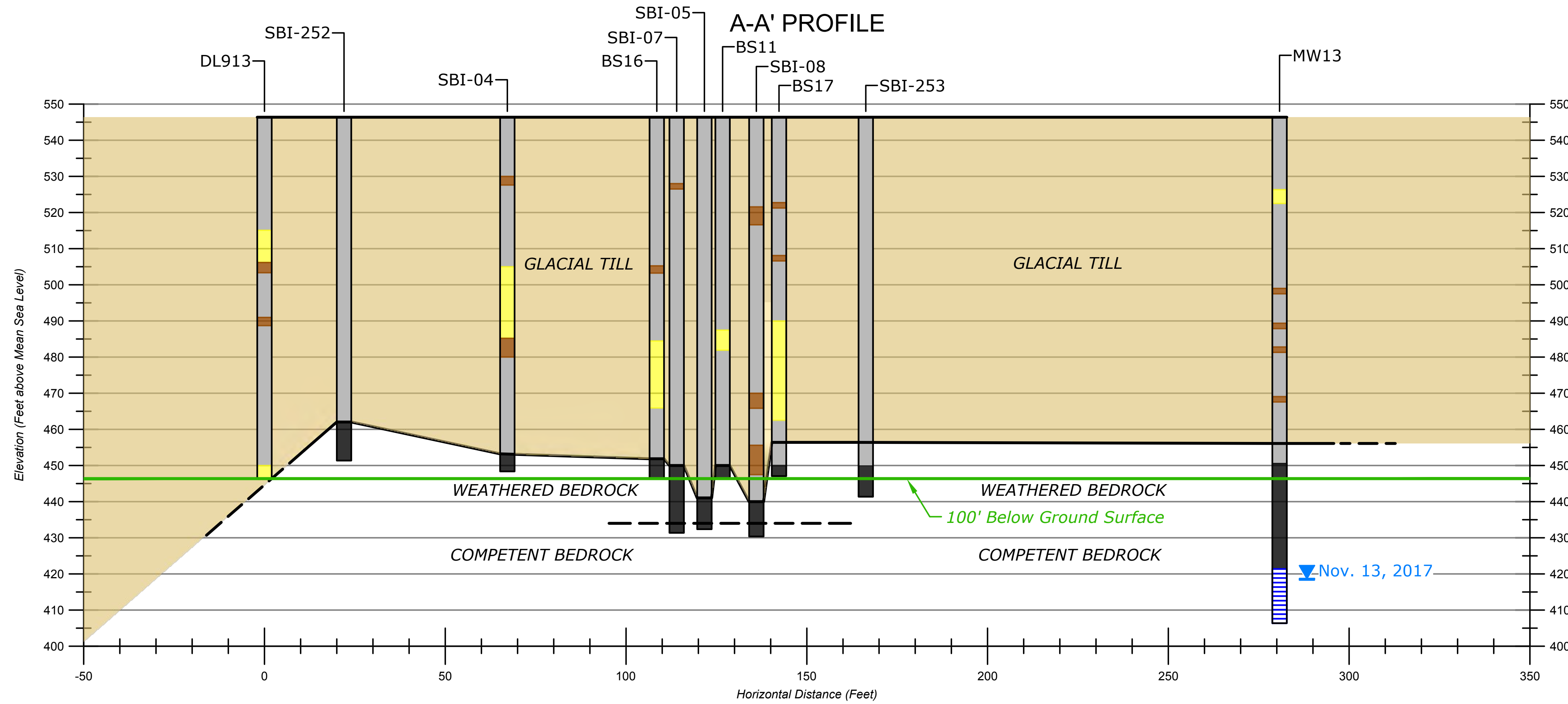

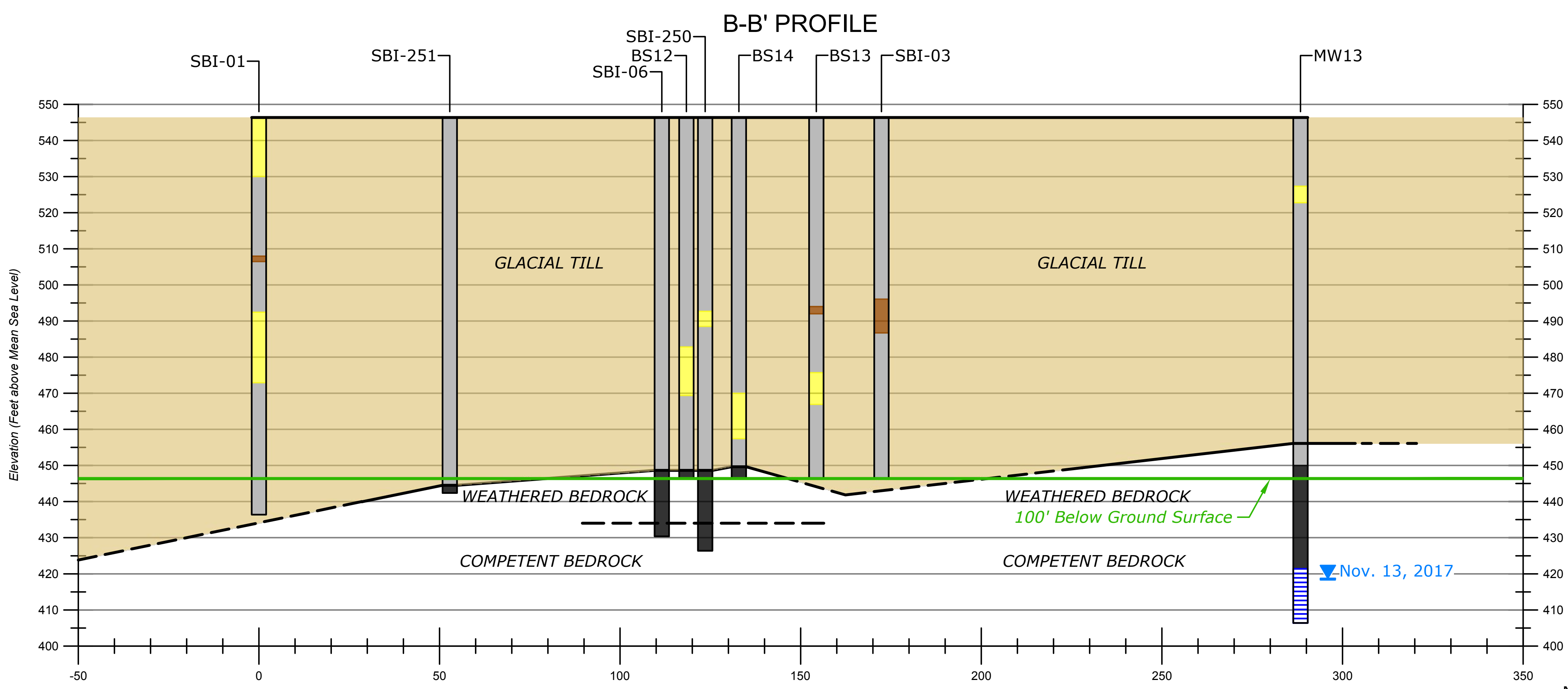

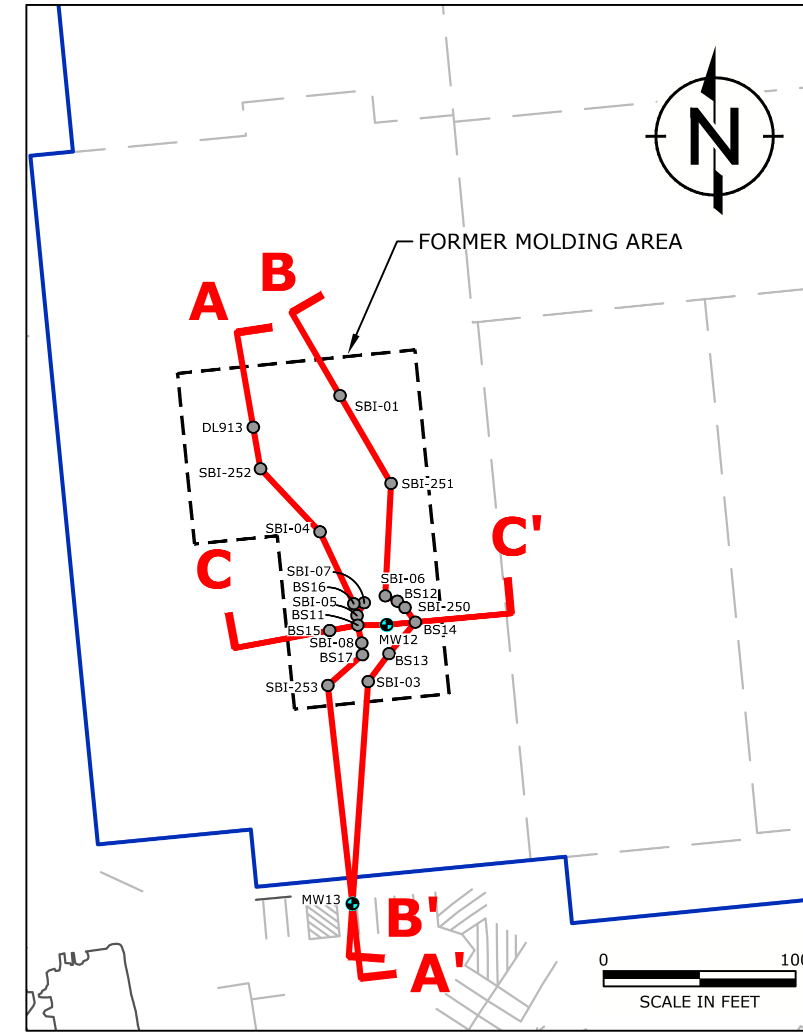

CROSS-SECTION LOCATIONS

LEGEND

- WELL / SOIL BORING
- SCREENED INTERVAL
- WATER LEVEL
- ML - SILT
- SW - SAND
- BD - BOULDERS
- Rx - BEDROCK

0 40
Horizontal Scale

0 40
Vertical Scale

No vertical exaggeration.

GEOLOGIC CROSS-SECTIONS A-A' and B-B'; OU3 TREATMENT AREA

POHATCONG VALLEY GROUNDWATER CONTAMINATION SUPERFUND SITE
OPERABLE UNIT (OU) 3
WARREN COUNTY, NEW JERSEY

RAMBOLL

FIGURE
3A

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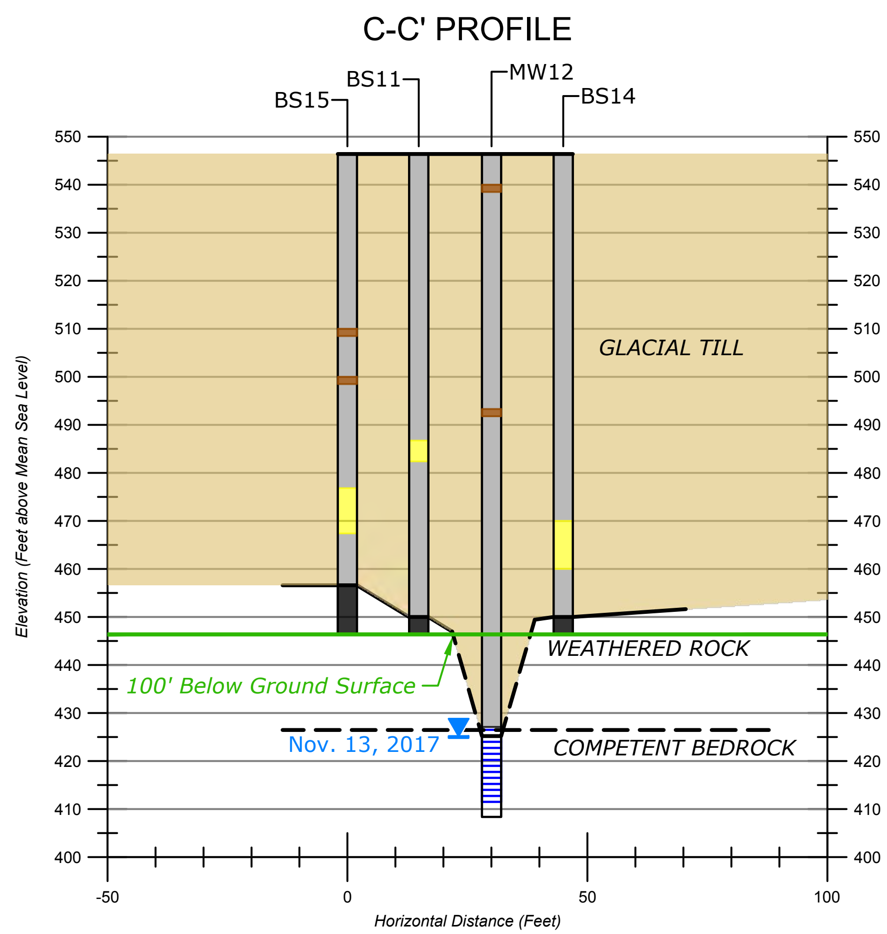
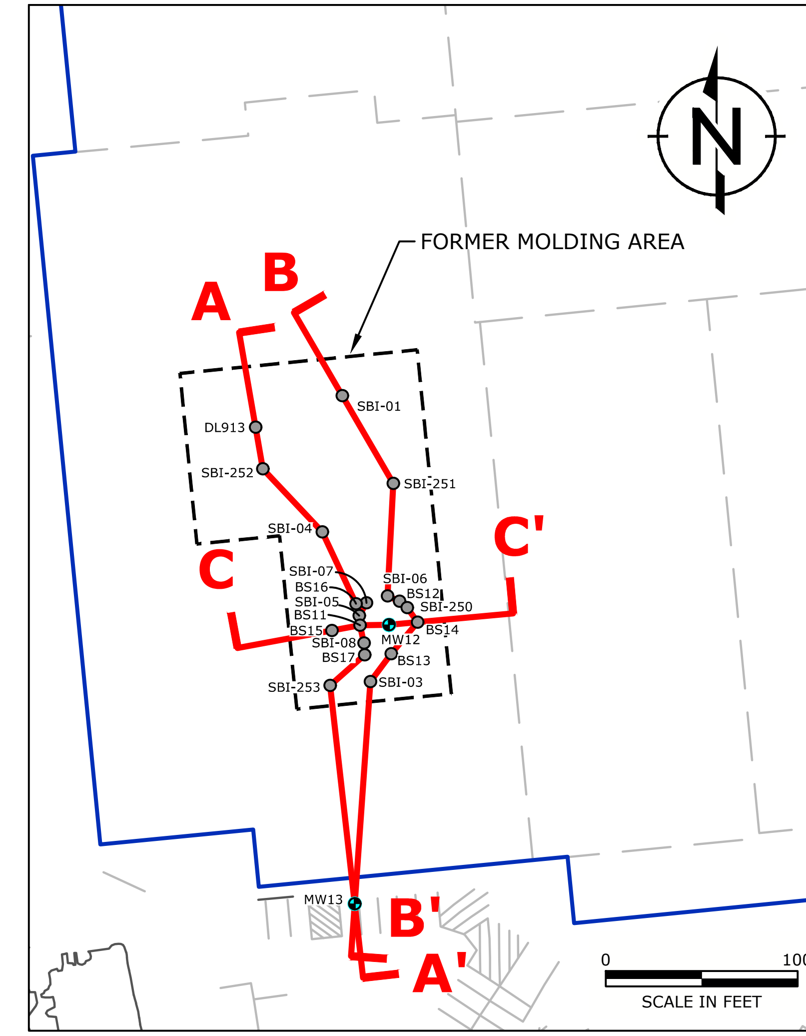
L:\Loop Project Files_CAD\1690005069 Rio Tinto\PVGCS_Acad\05_Cross Sections(2017-1214).dwg





CROSS-SECTION LOCATIONS

LEGEND

- WELL / SOIL BORING
- SCREENED INTERVAL
- WATER LEVEL
- ML - SILT
- SW - SAND
- BD - BOULDERS
- Rx - BEDROCK

0 40
Horizontal Scale

0 40
Vertical Scale

No vertical exaggeration.

GEOLOGIC CROSS-SECTION C-C'; OU3 TREATMENT AREA
POHATCONG VALLEY GROUNDWATER CONTAMINATION SUPERFUND SITE
OPERABLE UNIT (OU) 3
WARREN COUNTY, NEW JERSEY

RAMBOLL

FIGURE **3B**

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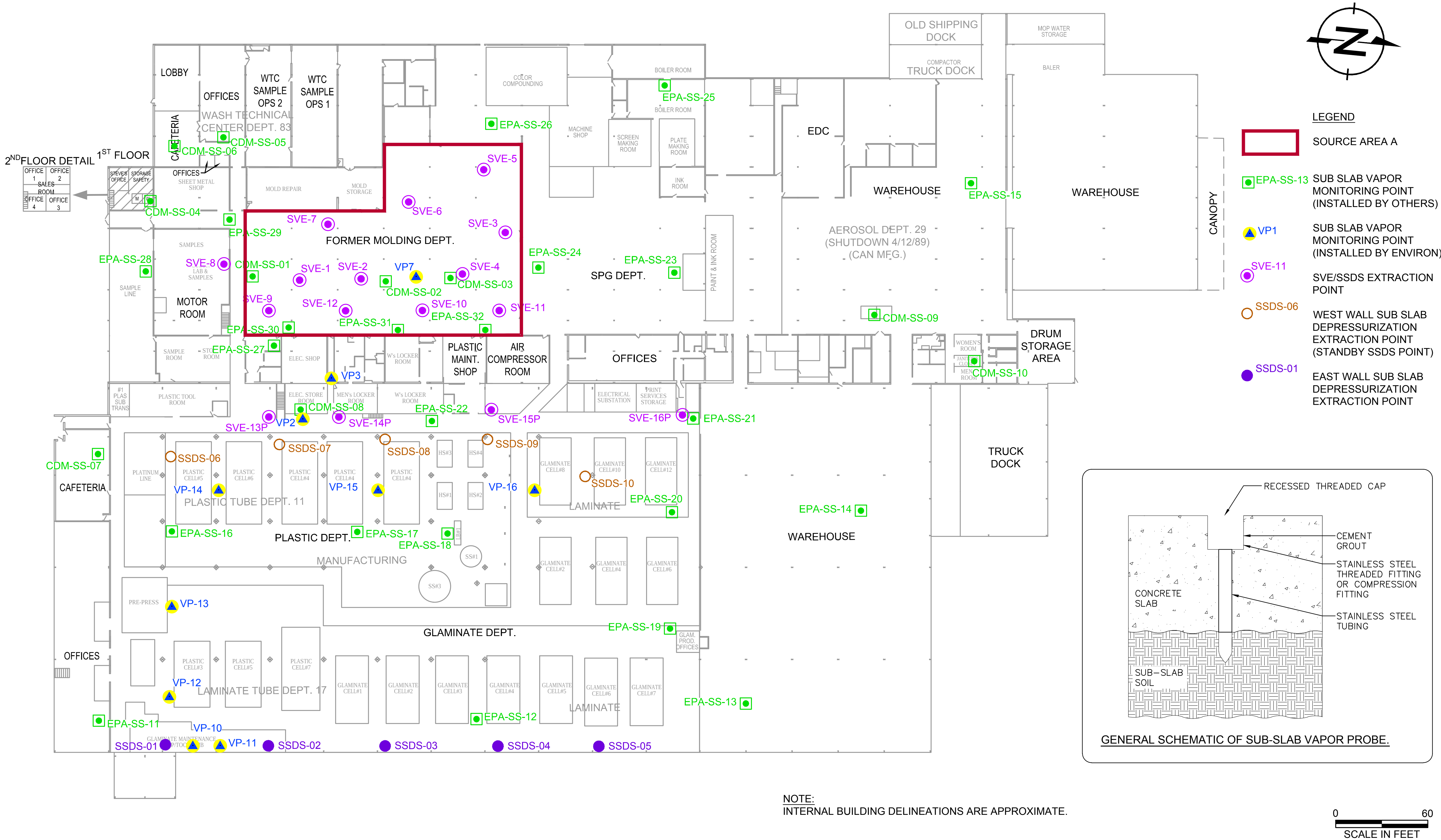


NOTE:
INTERNAL BUILDING DELINEATIONS ARE APPROXIMATE.

RAMBOLL

DRAFTED BY: MSB/KPM | DATE: 9/28/2018

LOCATIONS OF SVE WELLS, SSDS EXTRACTION WELLS, AND VAPOR MONITORING POINTS

VAPOR INTRUSION RESPONSE ACTIVITIES

ALBÉA AMERICAS, WASHINGTON FACILITY

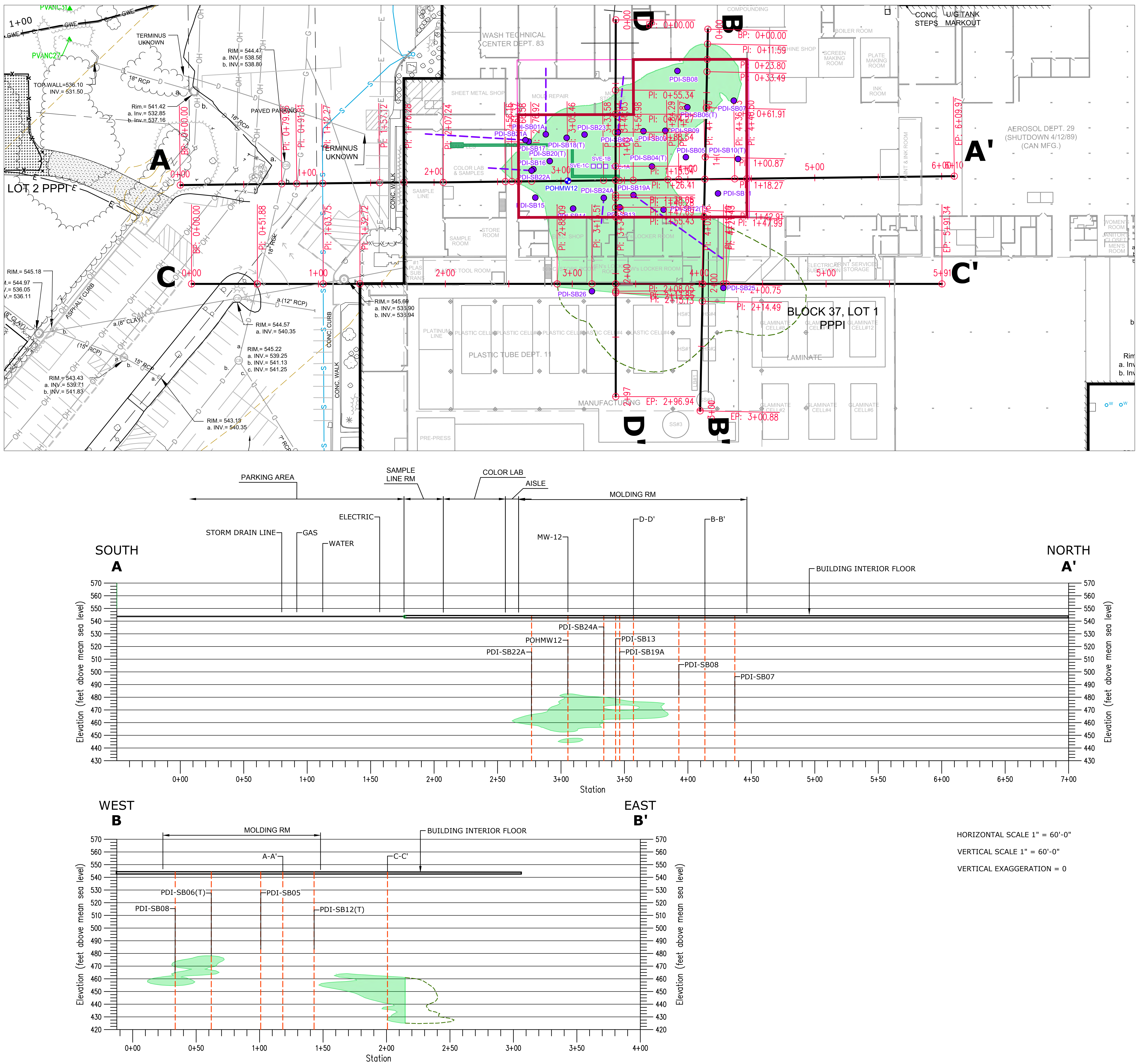
191 RT 31 NORTH, WASHINGTON, WARREN COUNTY, NJ

FIGURE

4

0211697J

ESANIDAD 9/28/18 [04_LOC OF VIRA SSDS EXTRACTION AND VMPS] L:\LOOP PROJECT FILES_CAD\1690008019-005_RT_WBS A3.B2.80 33 2413_OU3 MW12\PRELIM 30% DESIGN



LEGEND:

- MONITORING WELL
- ANGLED SOIL BORING
- SOIL BORING
- SVE PILOT TEST WELL
- (T) ISTR THERMOCOUPLE LOCATION
- BUILDING COLUMN
- SOURCE AREA A
- TRENCH DRAIN
- EXTENT OF TCE SOIL IMPACT (CONFINED VOLUME)
- EXTENT OF TCE SOIL (PROJECTED VOLUME 17,000 CUBIC YARDS)
- ELECTRIC LINE
- GAS LINE
- WATER LINE
- STORM DRAIN LINE

50 0 50 100

SCALE IN FEET

HORIZONTAL SCALE 1" = 60'-0"

VERTICAL SCALE 1" = 60'-0"

VERTICAL EXAGGERATION = 0

REV.	DATE	DR.	CH.	REVISION

EXTENT OF TCE IMPACTS CROSS SECTIONS A-A' & B-B'

POHATCONG VALLEY GROUNDWATER CONTAMINATION SUPERFUND SITE
OPERABLE UNIT (OU) 3
WARREN COUNTY, NEW JERSEY

RAMBOLL

PREPARED BY: ELS	DATE: 9/28/18	FIGURE
DRAFTED BY: ELS	SCALE: 1" = 50'	5A
APPROVED BY:	PROJECT: 1690008019	

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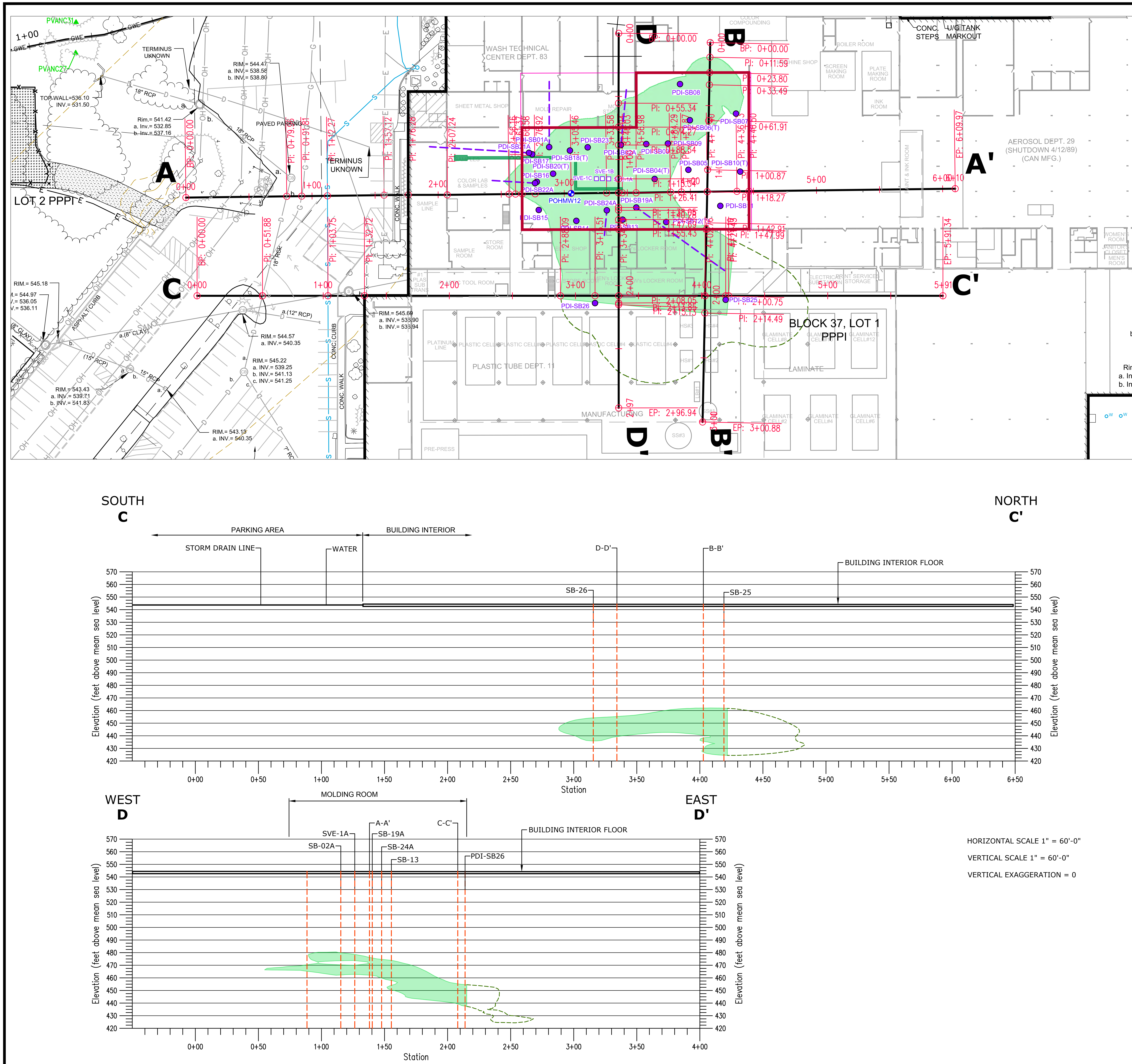

LEGEND:

- MONITORING WELL
- ANGLED SOIL BORING
- SOIL BORING
- SVE PILOT TEST WELL
- (T) ISTR THERMOCOUPLE LOCATION
- BUILDING COLUMN
- SOURCE AREA A
- TRENCH DRAIN
- EXTENT OF TCE SOIL IMPACT (CONFINED VOLUME)
- EXTENT OF TCE SOIL (PROJECTED VOLUME 17,000 CUBIC YARDS)
- E — ELECTRIC LINE
- G — GAS LINE
- S — WATER LINE
- D — STORM DRAIN LINE

50 0 50 100

SCALE IN FEET

HORIZONTAL SCALE 1" = 60'-0"

VERTICAL SCALE 1" = 60'-0"

VERTICAL EXAGGERATION = 0

REV.	DATE	DR.	CH.	REVISION

EXTENT OF TCE IMPACTS CROSS SECTIONS C-C' & D-D'

POHATCONG VALLEY GROUNDWATER CONTAMINATION SUPERFUND SITE
OPERABLE UNIT (OU) 3
WARREN COUNTY, NEW JERSEY

RAMBOLL

PREPARED BY: ELS	DATE: 9/28/18	FIGURE
DRAFTED BY: ELS	SCALE: 1" = 50'	5B
APPROVED BY:	PROJECT: 1690008019	

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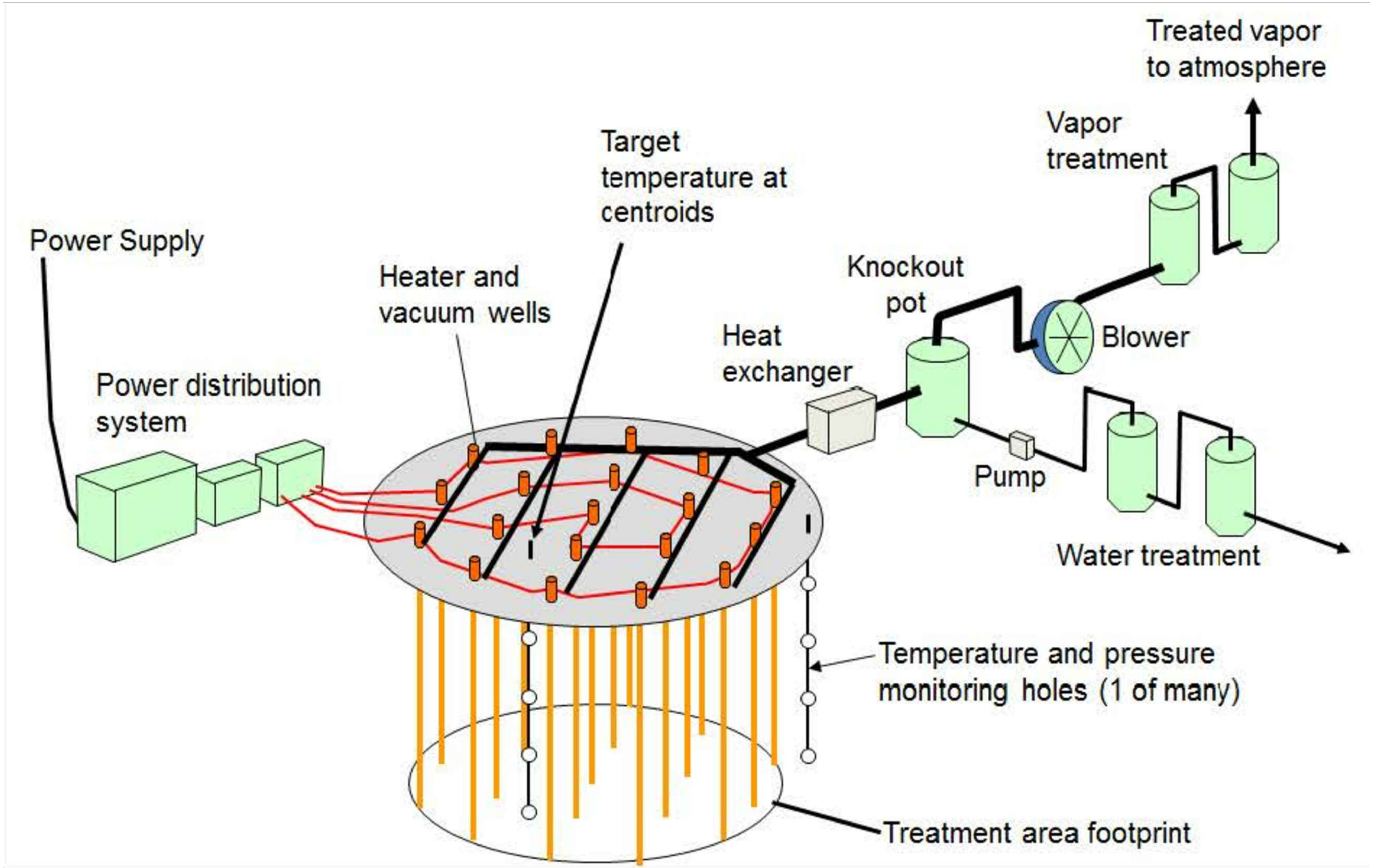


Source: Cascade Thermal, Inc., August 2018.

RAMBOLL

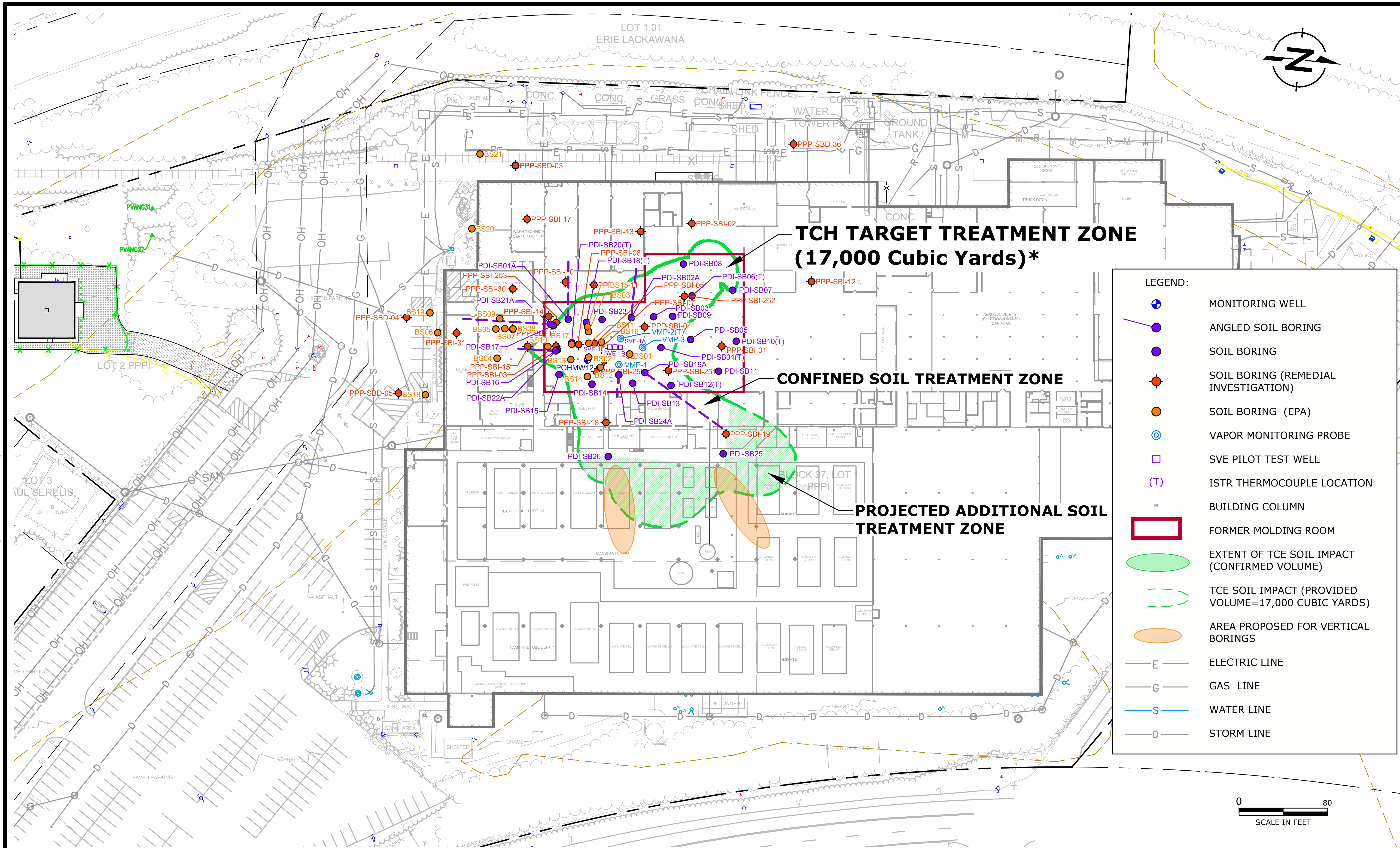
DRAFTED BY: ELS | DATE: 8/28/18

SCHEMATIC OF THERMAL CONDUCTIVE HEATING SYSTEM - VERTICAL INSTALLATION

POHATCONG VALLEY GROUNDWATER CONTAMINATION SUPERFUND SITE
OPERABLE UNIT (OU) 3
WARREN COUNTY, NEW JERSEY

FIGURE
6

1690008019



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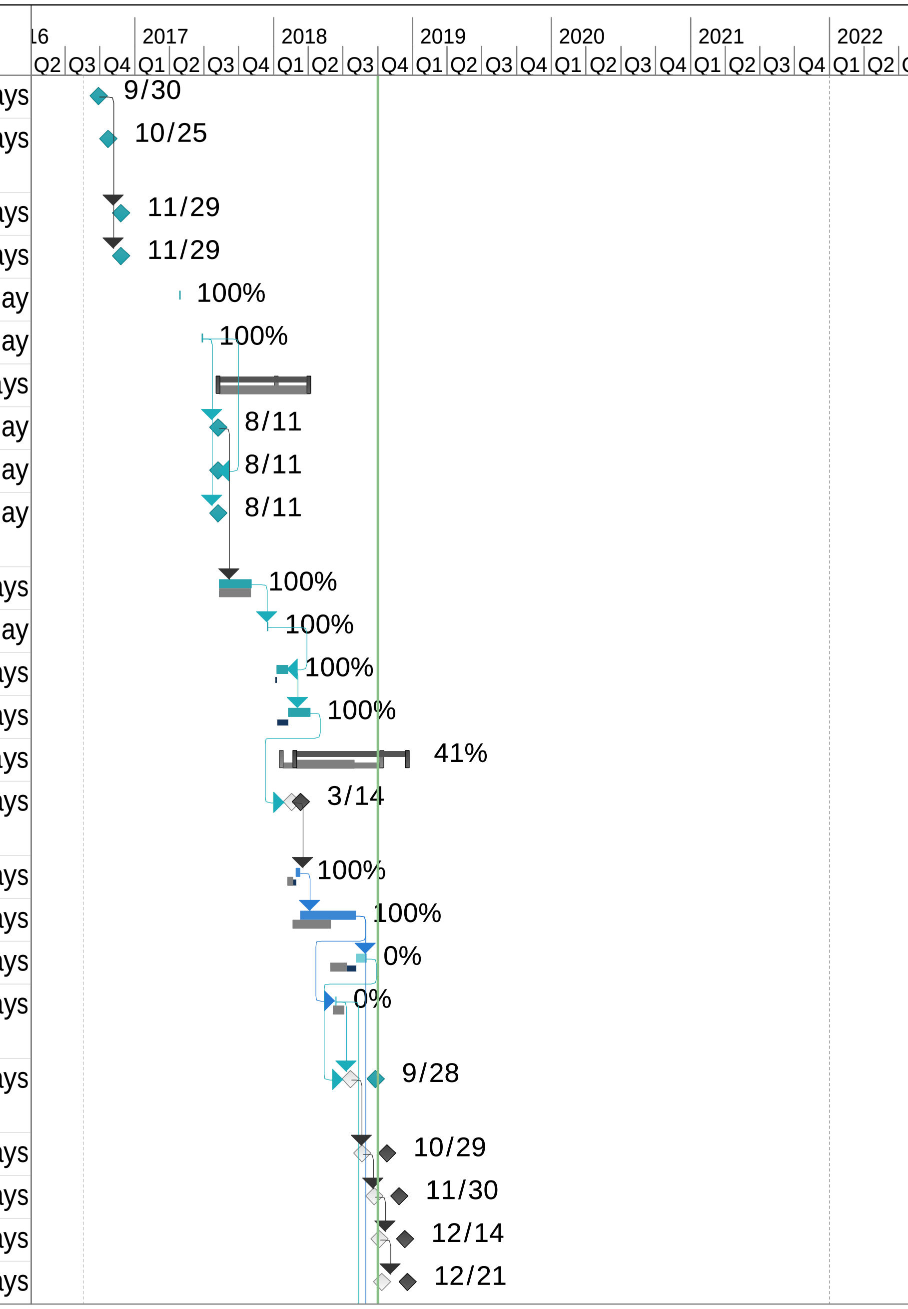
TCH TARGET TREATMENT ZONE
POHATCONG VALLEY GROUNDWATER CONTAMINATION SUPERFUND SITE
OPERABLE UNIT (OU) 3
WARREN COUNTY, NEW JERSEY

FIGURE
7
1690008019

FIGURE 8. RD/RA TIme Schedule
Preliminary (30%) Remedial Design, Operable Unit 3,
Pohatcong Valley Groundwater Contamination
Superfund Site, Warren County, New Jersey

ID	Task Name	Start	Finish	Baseline Start	Baseline Finish	Start Var.	Finish Var.
1	USEPA Issues OU3 ROD	Fri 9/30/16	Fri 9/30/16	Fri 9/30/16	Fri 9/30/16	0 days	0 days
2	PPPI Notice of Project Coordinator & Alt Project Coordinator (SOW III.B)	Tue 10/25/16	Tue 10/25/16	Tue 10/25/16	Tue 10/25/16	0 days	0 days
3	PPPI Notice of Supervising Contractor for OU3 (SOW III.A)	Tue 11/29/16	Tue 11/29/16	Tue 11/29/16	Tue 11/29/16	0 days	0 days
4	PPPI Performance Guarantee for OU3 Work	Tue 11/29/16	Tue 11/29/16	Tue 11/29/16	Tue 11/29/16	0 days	0 days
5	PPPI submittal of Draft OU3 Statement of Work (SOW)	Fri 4/28/17	Fri 4/28/17	Fri 4/28/17	Fri 4/28/17	0 days	1 day
6	USEPA Approval of Draft OU3 SOW	Mon 6/26/17	Mon 6/26/17	Mon 6/26/17	Mon 6/26/17	0 days	1 day
7	Remedial Design Work Plan (RDWP)	Thu 8/10/17	Thu 4/5/18	Thu 8/10/17	Tue 1/9/18	1 day	62 days
8	Submit Draft RDWP to USEPA (SOW VI)	Fri 8/11/17	Fri 8/11/17	Thu 8/10/17	Thu 8/10/17	1 day	1 day
9	Submit Health and Safety Plan (HSP) to USEPA (SOW VII.A)	Fri 8/11/17	Fri 8/11/17	Thu 8/10/17	Thu 8/10/17	1 day	1 day
10	Submit Quality Assurance Project Plan (QAPP) to USEPA (SOW VI.F)	Fri 8/11/17	Fri 8/11/17	Thu 8/10/17	Thu 8/10/17	1 day	1 day
11	USEPA Review & Comment on Draft RDWP (Estimated)	Thu 8/10/17	Thu 11/2/17	Thu 8/10/17	Thu 11/2/17	1.13 days	1.13 days
12	Submit Revised Draft RDWP to USEPA	Fri 12/15/17	Fri 12/15/17	Fri 12/15/17	Fri 12/15/17	0 days	1 day
13	USEPA Approval of Revised Draft RDWP	Mon 1/8/18	Tue 2/6/18	Fri 1/5/18	Fri 1/5/18	9 days	96 days
14	Submit Final RDWP to USEPA	Fri 2/9/18	Thu 4/5/18	Tue 1/9/18	Tue 1/9/18	22 days	62 days
15	Pre-Design Investigation (PDI)	Thu 3/1/18	Fri 12/21/18	Wed 1/24/18	Mon 10/15/18	26 days	48 days
16	Owner Settling Defendant Clearance of Large Equipment for PDI	Wed 3/14/18	Wed 3/14/18	Wed 1/24/18	Tue 2/20/18	36 days	16 days
17	PPPI Mobilization for PDI Activities	Thu 3/1/18	Fri 3/9/18	Wed 2/7/18	Tue 2/20/18	16 days	13 days
18	Implement Pre-Design Investigation	Mon 3/12/18	Fri 8/3/18	Wed 2/21/18	Tue 5/29/18	13 days	48 days
19	PDI Laboratory Analysis & Data Validation	Mon 8/6/18	Fri 8/31/18	Wed 5/30/18	Tue 7/10/18	48 days	38 days
20	Implement the Pilot/Treatability Study Work Plan (P/TSWP) (SOW VI.D)	Mon 6/11/18	Thu 6/14/18	Wed 6/6/18	Tue 7/3/18	3 days	-13 days
21	Submit Draft Pilot/Treatability Study Evaluation (P/TSE) Report to USEPA (SOW VI.D.3)	Fri 9/28/18	Fri 9/28/18	Tue 7/24/18	Tue 7/24/18	196.88 days	196.88 days
22	USEPA Review & Comment on Draft PTSE Report (Estimated)	Fri 9/28/18	Mon 10/29/18	Tue 7/24/18	Thu 8/23/18	196.88 days	199.88 days
23	Submit Revised Draft P/TSE Report to USEPA	Fri 11/30/18	Fri 11/30/18	Mon 9/24/18	Mon 9/24/18	48 days	48 days
24	USEPA Review & Approval of Revised Draft P/TSE Report	Fri 11/30/18	Fri 12/14/18	Mon 9/24/18	Mon 10/8/18	199.88 days	199.88 days
25	Submit Final P/TSE Report to USEPA	Fri 12/21/18	Fri 12/21/18	Mon 10/15/18	Mon 10/15/18	48 days	48 days



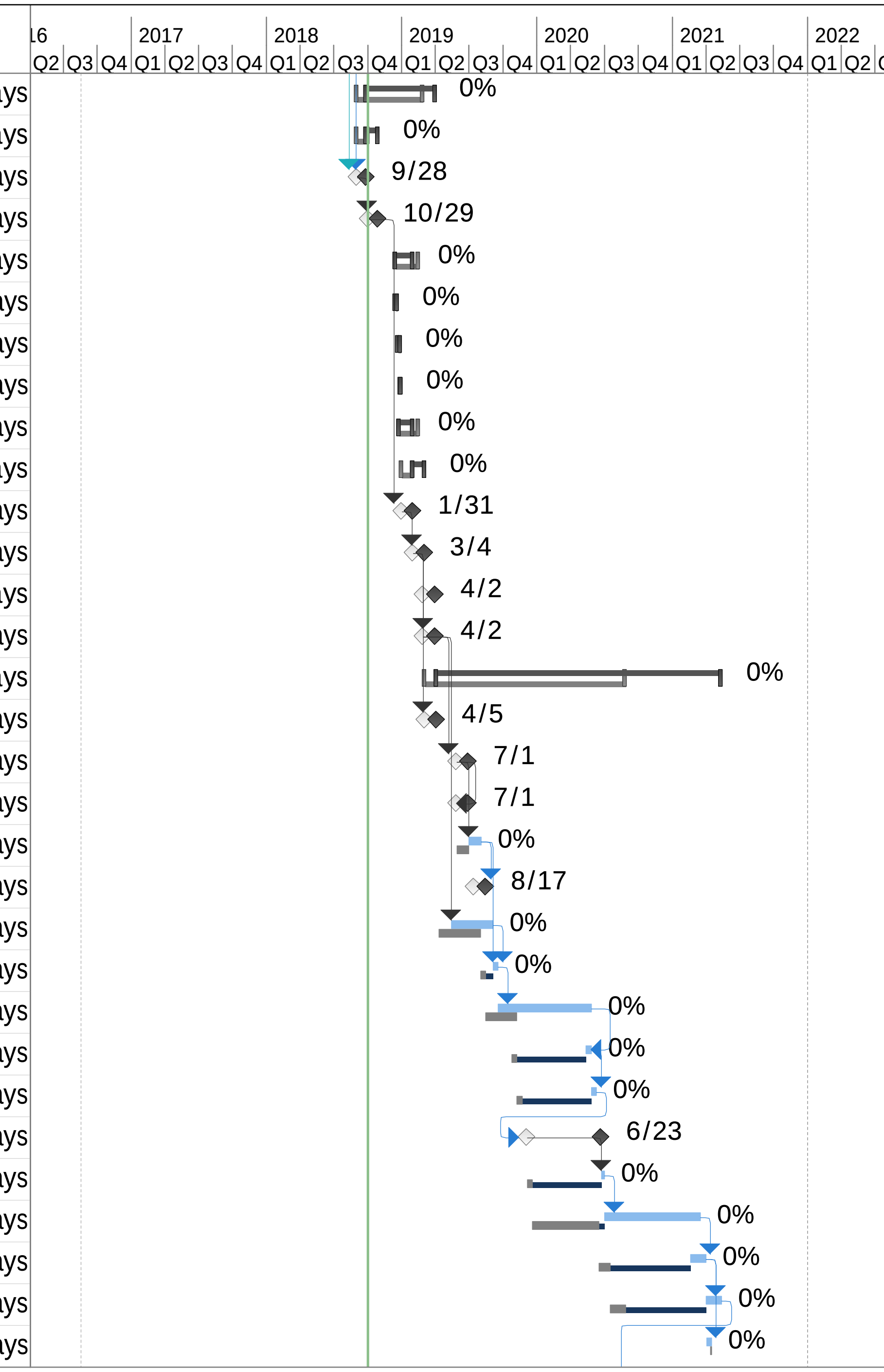
Date: 9/28/2018
Version: 0

Baseline Milestone	Task	Finish-only	Summary	Inactive Task
Baseline Summary	Split	Duration-only	Manual Summary	Inactive Milestone
Critical	Task Progress	Baseline Split	Project Summary	Inactive Summary
Critical Split	Manual Task	Milestone	External Tasks	Deadline
Critical Progress	Start-only	Summary Progress	External Milestone	Slippage
Baseline				

RAMBOLL

FIGURE 8. RD/RA TIme Schedule
Preliminary (30%) Remedial Design, Operable Unit 3,
Pohatcong Valley Groundwater Contamination
Superfund Site, Warren County, New Jersey

ID	Task Name	Start	Finish	Baseline Start	Baseline Finish	Start Var.	Finish Var.
26	Remedial Design (RD)	Fri 9/28/18	Tue 4/2/19	Mon 9/3/18	Thu 2/28/19	19 days	23 days
27	Preliminary 30% Design	Fri 9/28/18	Mon 10/29/18	Mon 9/3/18	Wed 10/3/18	19 days	18 days
28	Submit Preliminary 30% Design Report to USEPA (SOW IX.A)	Fri 9/28/18	Fri 9/28/18	Mon 9/3/18	Mon 9/3/18	19 days	19 days
29	USEPA Review & Comment on 30% Design	Fri 9/28/18	Mon 10/29/18	Mon 9/3/18	Wed 10/3/18	75 days	78 days
30	Additional PDI Soil Borings in MPA (Vertical)	Mon 12/17/18	Thu 1/31/19	Mon 12/17/18	Fri 2/15/19	0 days	-11 days
31	Predrilling Activities	Mon 12/17/18	Fri 12/21/18	Mon 12/17/18	Fri 12/21/18	0 days	0 days
37	Drilling Activities	Mon 12/24/18	Sat 12/29/18	Mon 12/24/18	Sat 12/29/18	0 days	0 days
56	Post Drilling activities	Sun 12/30/18	Mon 12/31/18	Sun 12/30/18	Mon 12/31/18	0 days	0 days
63	Data Assessment and Reporting	Thu 12/27/18	Thu 1/31/19	Thu 12/27/18	Fri 2/15/19	0 days	-11 days
70	Pre-Final 90% Design	Thu 1/31/19	Mon 3/4/19	Tue 1/1/19	Thu 1/31/19	22 days	22 days
71	Submit Pre-Final 90% Design to USEPA	Thu 1/31/19	Thu 1/31/19	Tue 1/1/19	Tue 1/1/19	22 days	22 days
72	USEPA Review of 90% Design & Approval of Design Report	Thu 1/31/19	Mon 3/4/19	Tue 1/1/19	Thu 1/31/19	90 days	96 days
73	Final 100% Design	Tue 4/2/19	Tue 4/2/19	Thu 2/28/19	Thu 2/28/19	23 days	23 days
74	Submit Final 100% Design to USEPA	Tue 4/2/19	Tue 4/2/19	Thu 2/28/19	Thu 2/28/19	23 days	23 days
75	Remedial Action (RA) - ISTR	Fri 4/5/19	Wed 5/12/21	Mon 3/4/19	Thu 8/27/20	24 days	184 days
76	Award of Contract to Construction Contractor (SOW XI)	Fri 4/5/19	Fri 4/5/19	Mon 3/4/19	Mon 3/4/19	24 days	24 days
77	Submit Remedial Action Work Plan (RAWP) to USEPA (SOW XI.A)	Mon 7/1/19	Mon 7/1/19	Wed 5/29/19	Wed 5/29/19	23 days	23 days
78	Submit HSP for Remedial Action to USEPA	Mon 7/1/19	Mon 7/1/19	Wed 5/29/19	Wed 5/29/19	23 days	23 days
79	USEPA Review & Comment on RAWP	Mon 7/1/19	Fri 8/2/19	Wed 5/29/19	Sun 6/30/19	99 days	99 days
80	Submit Final RA Work Plan to USEPA	Sat 8/17/19	Sat 8/17/19	Mon 7/15/19	Mon 7/15/19	24 days	24 days
81	Equipment Procurement	Wed 5/15/19	Tue 9/3/19	Fri 4/12/19	Thu 8/1/19	23 days	23 days
82	Mobilize to Initiate Remedial Action (SOW XI.C.1)	Wed 9/4/19	Tue 9/17/19	Fri 8/2/19	Thu 8/15/19	23 days	23 days
83	Remedial Construction	Wed 9/18/19	Tue 5/26/20	Fri 8/16/19	Thu 11/7/19	23 days	143 days
84	Pre-Final Inspection with USEPA (SOW XII.A.1)	Tue 5/12/20	Tue 5/26/20	Thu 10/24/19	Thu 11/7/19	603 days	603 days
85	Punch List Corrective Actions (Assumed)	Tue 5/26/20	Tue 6/9/20	Thu 11/7/19	Thu 11/21/19	603 days	603 days
86	Follow-on Inspection with USEPA (if needed)	Tue 6/23/20	Tue 6/23/20	Thu 12/5/19	Thu 12/5/19	143 days	143 days
87	RA Shakedown Testing & Startup	Wed 6/24/20	Tue 6/30/20	Fri 12/6/19	Thu 12/19/19	143 days	138 days
88	RA OM&M	Tue 6/30/20	Wed 3/17/21	Thu 12/19/19	Tue 6/16/20	582 days	822 days
89	Confirmation Sampling	Wed 2/17/21	Wed 3/31/21	Tue 6/16/20	Thu 7/16/20	738 days	774 days
90	Laboratory Analysis & Data Validation	Wed 3/31/21	Wed 5/12/21	Thu 7/16/20	Thu 8/27/20	774 days	774 days
91	Demobilization	Fri 4/2/21	Fri 4/16/21	Wed 4/14/21	Fri 4/16/21	-34.88 days	0 days



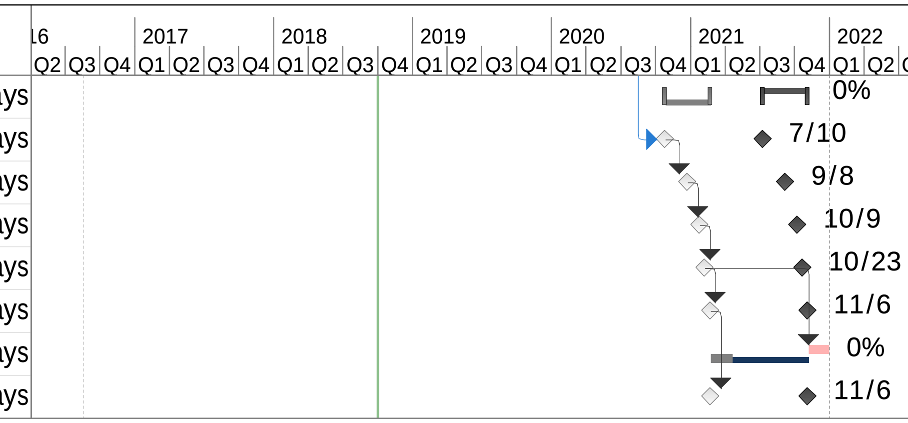
Baseline Milestone		Task		Finish-only		Summary		Inactive Task		Baseline
Baseline Summary		Split		Duration-only		Manual Summary		Inactive Milestone	
Critical		Task Progress		Baseline Split		Project Summary		Inactive Summary	
Critical Split		Manual Task		Milestone		External Tasks		Deadline	
Critical Progress		Start-only		Summary Progress		External Milestone		Slippage	

Date: 9/28/2018
Version: 0

RAMBOLL

FIGURE 8. RD/RA TIme Schedule
Preliminary (30%) Remedial Design, Operable Unit 3,
Pohatcong Valley Groundwater Contamination
Superfund Site, Warren County, New Jersey

ID	Task Name	Start	Finish	Baseline Start	Baseline Finish	Start Var.	Finish Var.
92	Remedial Action (RA) Report	Sat 7/10/21	Sat 11/6/21	Mon 10/26/20	Mon 2/22/21	184 days	184 days
93	Submit Draft RA Report to USEPA (SOW XI.B.1)	Sat 7/10/21	Sat 7/10/21	Mon 10/26/20	Mon 10/26/20	184 days	184 days
94	USEPA Review & Comment on Draft RA Report	Sat 7/10/21	Wed 9/8/21	Mon 10/26/20	Fri 12/25/20	771 days	771 days
95	Submit Revised Draft RA Report to USEPA	Sat 10/9/21	Sat 10/9/21	Mon 1/25/21	Mon 1/25/21	184 days	184 days
96	USEPA Review & Approval of Revised Draft RA Report	Sat 10/9/21	Sat 10/23/21	Mon 1/25/21	Mon 2/8/21	771 days	771 days
97	Submit Final RA Report to USEPA	Sat 11/6/21	Sat 11/6/21	Mon 2/22/21	Mon 2/22/21	184 days	184 days
98	RA Decommissioning & Abandonment	Mon 11/8/21	Fri 12/31/21	Tue 2/23/21	Mon 4/19/21	184 days	184 days
99	Commence Long-term Monitoring	Sat 11/6/21	Sat 11/6/21	Mon 2/22/21	Mon 2/22/21	184 days	184 days



Date: 9/28/2018
Version: 0

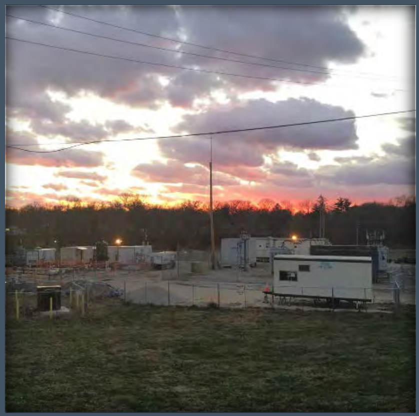
Baseline Milestone		Task		Finish-only		Summary		Inactive Task	
Baseline Summary		Split		Duration-only		Manual Summary		Inactive Milestone	
Critical		Task Progress		Baseline Split		Project Summary		Inactive Summary	
Critical Split		Manual Task		Milestone		External Tasks		Deadline	
Critical Progress		Start-only		Summary Progress		External Milestone		Slippage	
Baseline									

APPENDIX A

THERMAL DESORPTION MODELING REPORT

ADVISE | DESIGN | BUILD | OPERATE

CASCADE THERMAL



Thermal Model Simulation Report

In Situ Thermal Desorption

Pohatcong Valley Groundwater Contamination Superfund Site

Washington, NJ

Prepared for

Ramboll

www.cascade-env.com

Table of Contents

1 Introduction

The Pohatcong Valley Groundwater Contamination Super Fund Site in Washington, NJ "the site" will be treated thermally to reduce TCE concentrations in the vadose zone soils. The energy use and operational duration are important factors for planning and executing the work. Therefore, a water and energy balance code has been developed by Cascade Thermal to simulate the addition, removal, and loss of energy in each layer of the site separately, with the layers exchanging both fluids (water and steam) and energy along their boundaries. The calculations also estimate heat losses along the top, sides, and bottom of the treatment zone, such that relatively accurate total energy demands are derived.

The water and energy balance calculations are referred to as "the model" in the following paragraphs. In the following sections the basic model setup is described, along with the specific goals expected to be derived on the basis of the conducted water and energy balance calculations.

The thermal remediation at the site uses Thermal Conduction Heating (TCH) utilizing Cascade Thermal's patented In-Situ Thermal Desorption (ISTD) technology. Electrically powered ISTD heaters will heat the Target Treatment Zone (TTZ).

2 Description of Numerical Model

The model is based on simplified mass and energy balance principles relevant for thermal operation. The model can include up to 12 layers each with different model input and derived parameters including:

- Surface area
- Depth
- Area of perimeter
- Porosity
- Initial saturation
- Initial bulk density
- Initial heat capacity
- Initial thermal conductivity

During the simulations, parameters such as thermal conductivity and heat capacity are changed automatically as the water saturation changes, based on published equations for these parameters. This means, for instance, that as a zone is drying out due to boiling and steam removal, the water saturation is reduced, and therefore both the heat capacity and thermal conductivity are reduced, such that only the remaining water contributes to these parameters. This gives a more realistic heating prediction than if constant values are assumed.

The results of the numerical simulations will serve as the basis for the design of the thermal treatment system at the site.

The geology of the Site consists of glacial till, moraine and fluvial unconsolidated overburden deposits comprised predominantly of silt with varying content of clay, sand, gravel, cobbles and occasional boulders to the top of bedrock, typically between 125 to 130 ft bgs. The silt coarsens downward and generally becomes sandier towards the bedrock interface. The silt is characterized as dry and hard, containing trace cobbles and boulders. Below the silt is a weathered carbonate bedrock.

The water table within the OU3 source area typically varies between 120 to 129 ft bgs, so the entire TTZ is in the vadose zone. An average water table location of 125ft bgs was assumed for this evaluation which is below the bottom of the modeled interval. A typical porosity of 0.4 was assumed for the glacial till. This is a conservative estimate given the poor sorting of glacial deposits.

Figure 2.1 shows the simplified layers of the treatment area at the Site that served as the basis for setting up the Site model. The depths are based on the average TTZ extent, the TTZ gets deeper as one moves east.

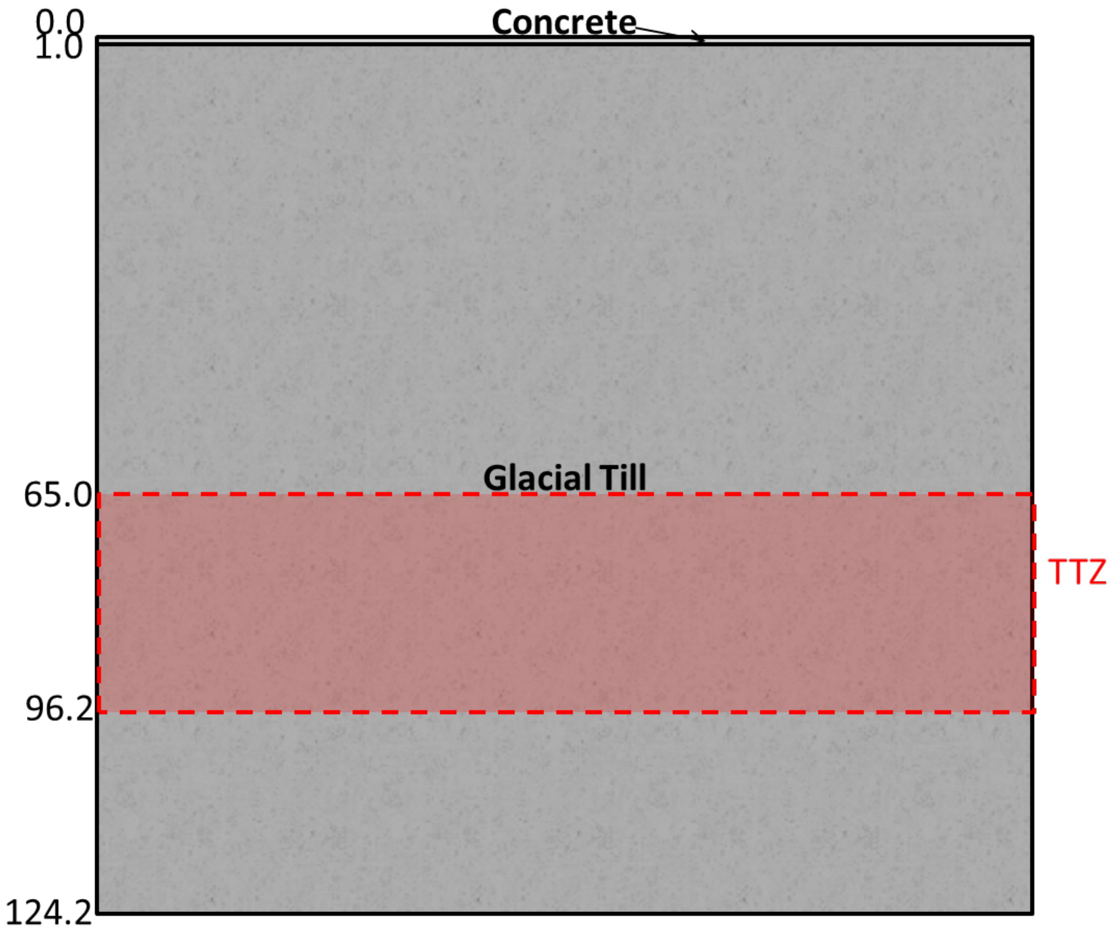


Figure 2.1 – Schematic Showing the Conceptual Geology Assumed in the Treatment Area.

The modeled TTZ extends from 65 to 96.2 ft bgs. An average TTZ thickness was calculated for the site based on e-mails from Ramboll indicating that TCE >1 mg/kg was encountered approximately between 65 to 100ft bgs beneath the former Molding Room Area and between 80 to 122ft bgs beneath the Main Production area. The wellfield layout (Figure 3.1) and the 3D cross-section of wells overlaying the EVS model (Figure 3.2) show that the wells were designed to target the depths indicated for the respective areas.

Thus the top of TTZ of 65ft bgs was assumed for the model since the treatment zone below the main production area needs to be further delineated so the 65ft top of TTZ seemed more appropriate for this evaluation. Using the heated lengths necessary to target the volume provided by Ramboll an average treated thickness of 31.2ft was calculated. This is less than the 35ft of TTZ beneath the former Molding Room Area and the 42ft of TTZ beneath the Main Production area because as shown in Figure 3.2, the top and bottom of the TTZ varies across the site and it was determined that 31.3 represents the average thickness while the 65 to 100 and 80 to 122 in the two areas identified by Ramboll represent the extremes of the TTZ extent. The target volume, based on the EVS output of TCE exceeding 1 mg/kg, is approximately 17,000 cy. Based on the average TTZ thickness of 31.2ft and the treatment area of 23,566ft^2 the total treatment volume in the model is 27,200cy. The volume is larger than 17,000 cy because heating cannot be surgical to the small-scale variations in the TCE contours.

For each layer, the water mass balance is calculated as follows:

$$M_{Net\ extraction} = M_{Out-Liquid} + M_{Out-Vapor} - M_{Injected} - M_{Inflow}$$

where M denotes cumulative water masses. Note that no fluids are injected when using the ISTD technology. Exchange of fluids between the layers is estimated based on hydrogeologic parameters and pumping rates. Since the entire TTZ is in the vadose zone at this site, it is assumed that groundwater influx is zero and that no pumping is necessary such that all water exchange between layers in the model is in the steam or vapor phase.

The mass removal in the liquid form is a simple summation of flow rate measurements:

$$M_{Out-Liquid} = \sum \left(m_{Liquid} \Delta t\right)$$

where the values for the flow rate m_{Liquid} are determined manually for each operational phase.

The water mass removal in the form of vapor (steam, water vapor) is calculated as follows:

$$M_{Out-Vapor} = \sum \left(m_{steam} \Delta t\right) = \sum \left(m_{total\ vapor} - m_{non-cond}\right) \Delta t$$

where m_{steam} is the vapor flow rate made up of steam, m_{total} vapor is the total incoming vapor flow rate, and non-condensable mass, $m_{non-cond}$ is the vapor flow rate minus the steam component (air mostly).

For these simulations, the steam extraction rates are calculated based on the energy injected by the ISTD system. The equation calculating the ratio between injected energy and extracted steam is derived based on observations made on several recent full-scale ISTD projects. **Figure 2.2** illustrates the streams that take part in the water mass balance within the heated zone (HZ).

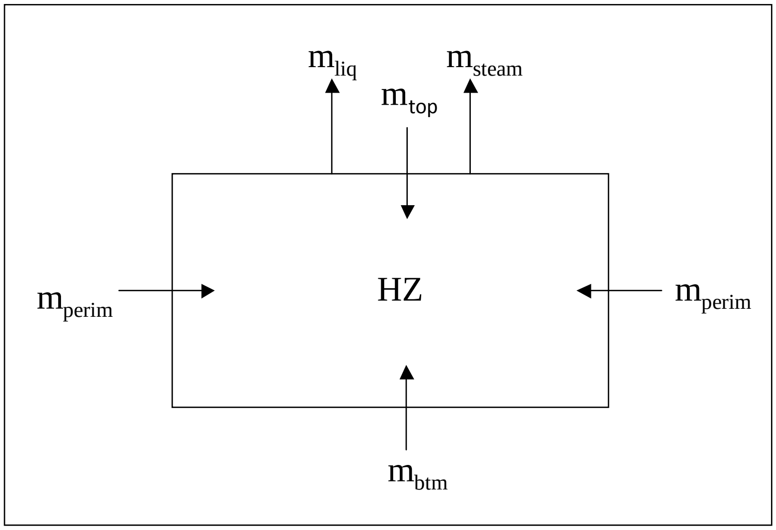


Figure 2.2 – Mass Balance Principles for Water (One Layer Shown for Simplicity)

Total water extraction rates are estimated by the sum of the measured flows:

$$m_{extraction} = m_{liquid} + m_{steam}$$

The model keeps track of the volume or mass of water stored in each layer, based on extracted water and estimates for the influx of water from the sides, bottom, and top by infiltration (the perimeter and bottom arrows shown on Figure 2.2) and water injected as steam.

$$M_{present,\,t1} = M_{present,\,t0} - M_{liquid} - M_{steam\ extr.} + M_{steam\ inject} + M_{bottom} + M_{perimeter}$$

where M denotes cumulative water masses.

The quantity of water removed from the subsurface is readily measured during operations. Therefore, this quantity can be compared to a relatively accurate estimate of the pre-treatment quantity of water within each layer, based on values of porosity and saturation for the different zones below the vapor cap and to total depth.

For the site it was assumed that any water infiltration into the TTZ from the top is unlikely given the depth of the TTZ and the short time-frame for operations.

Cumulative energy (E) is calculated as a summation of enthalpy fluxes (Q):

$$E = \sum (Q\,\Delta t)$$

An estimated energy balance is maintained for each layer in the model based on energy delivered by the ISTD-heaters, energy extracted in the vapor and liquid streams and heat loss to the areas outside of the HZ.

$$E_{in} = E_{out} + E_{storage} + E_{loss}$$

The energy fluxes are related for each time step as follows:

$$Q_{in} = Q_{out} + Q_{storage} + Q_{loss}$$

Where Q denotes enthalpy flux (in BTU/hr). **Figure 2.3** shows the schematic energy balance for one layer.

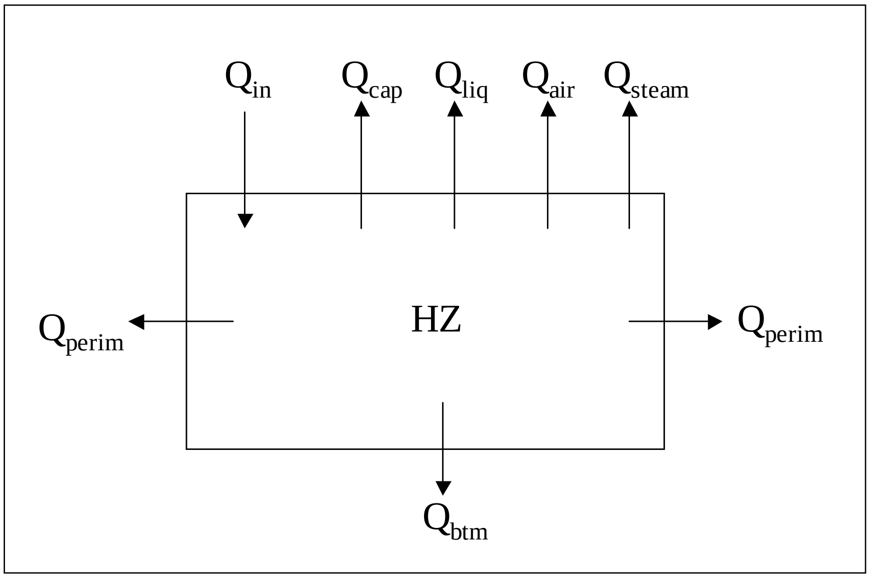


Figure 2.3 – Energy Balance Schematic (One Layer Shown for Simplicity)

The estimate for Q_{in} will be based on the ISTD energy input. The total energy removal from each layer is estimated as follows:

$$Q_{out} = Q_{liq} + Q_{non\ cond.\ gas} + Q_{steam\ out}$$

The energy flux in the extracted liquid is given by:

$$Q_{liq} = m_{liquid}\, c_{p,water}\left(T - T_0\right)$$

Where c_p is heat capacity and T_0 is the ambient temperature.

For the extracted vapor stream, the energy flux in steam is estimated as follows:

$$Q_{steam\ out} = m_{condensate}\, \Delta H_{steam-ambient}$$

where m is mass flux and H is specific enthalpy (in BTU/lb).The enthalpy of the steam can be estimated from steam tables.

The energy removed as a non-condensable vapor at any given time is relatively small due to the low heat capacity of air in relation to steam and water, and is therefore ignored in the calculations.

The actual heat loss cannot be calculated using accurate measures. An estimate can be made based on thermal profiles at the bottom and top of each layer, and along the perimeter, using the following calculations:

$$Q_{heat\ loss} = A K_T \frac{dT}{dz}$$

where A is the surface area through which energy is conducted, K_T is the thermal conductivity of the subsurface material, and dT/dz is the temperature gradient across the surface also expressed as $(T_1\text{-}T_2)/(z_1\text{-}z_2)$.

For the heat loss through the top, bottom and sides of the TTZ, the temperature difference between the layer average temperature and ambient temperature can be used to calculate a gradient. For the calculations, it is assumed that soil outside of the TTZ remains near ambient temperatures. The layers exchange energy by thermal conduction such that energy leaves the warmer layer and enters the cooler layer.

All heat migration through the boundaries of the TTZ in the model are considered lost from the model domain. Heat migration from the bottom of a layer and into the top of the underlying layer remains as energy in the model if both layers are in the heated zone.

The model calculates average layer temperatures based on the energy balance and the estimated heat capacity of each layer. The stored energy is related to the heated zone heat capacity and the average temperature as follows:

$$E_{storage} = C_{p,site}\left(T_{avg} - T_0\right) + m_{steam}\,\Delta_{steam-ambient}$$

Where $C_{p,site}$ is the overall heat capacity of the heated layer, estimated from the volume, saturation, and specific heat capacity of the soil and water:

$$C_{p,site} = V_{soil}C_{p,soil} + V_{water}C_{p,water}$$

The steam energy stored as a vapor at any given time is relatively small, and will be neglected in the calculations. For comparison with the measured temperatures, the energy balance can be used to estimate the average temperature ($T_{energybal}$) of the heated volume:

$$T_{energybal} = T_0 + \frac{E_{storage}}{C_{p,site}} = T_0 + \frac{(E_{in} - E_{out} - E_{loss})}{C_{p,site}}$$

Based on available site specific data for the Site, a basic scenario was set up in the water and energy balance model.

3 Discussion of Simulation Results

As described in the following paragraphs, results of the calculations indicate that the use of ISTD heating will be a very effective means of heating the Site.

The thermal treatment area is shown in **Figure 3.1** with a conceptual layout of heaters and wells. The treatment area has been divided into smaller subareas defined by the bottom of the TTZ as shown in the figure. The heater spacing is approximately 17 ft.

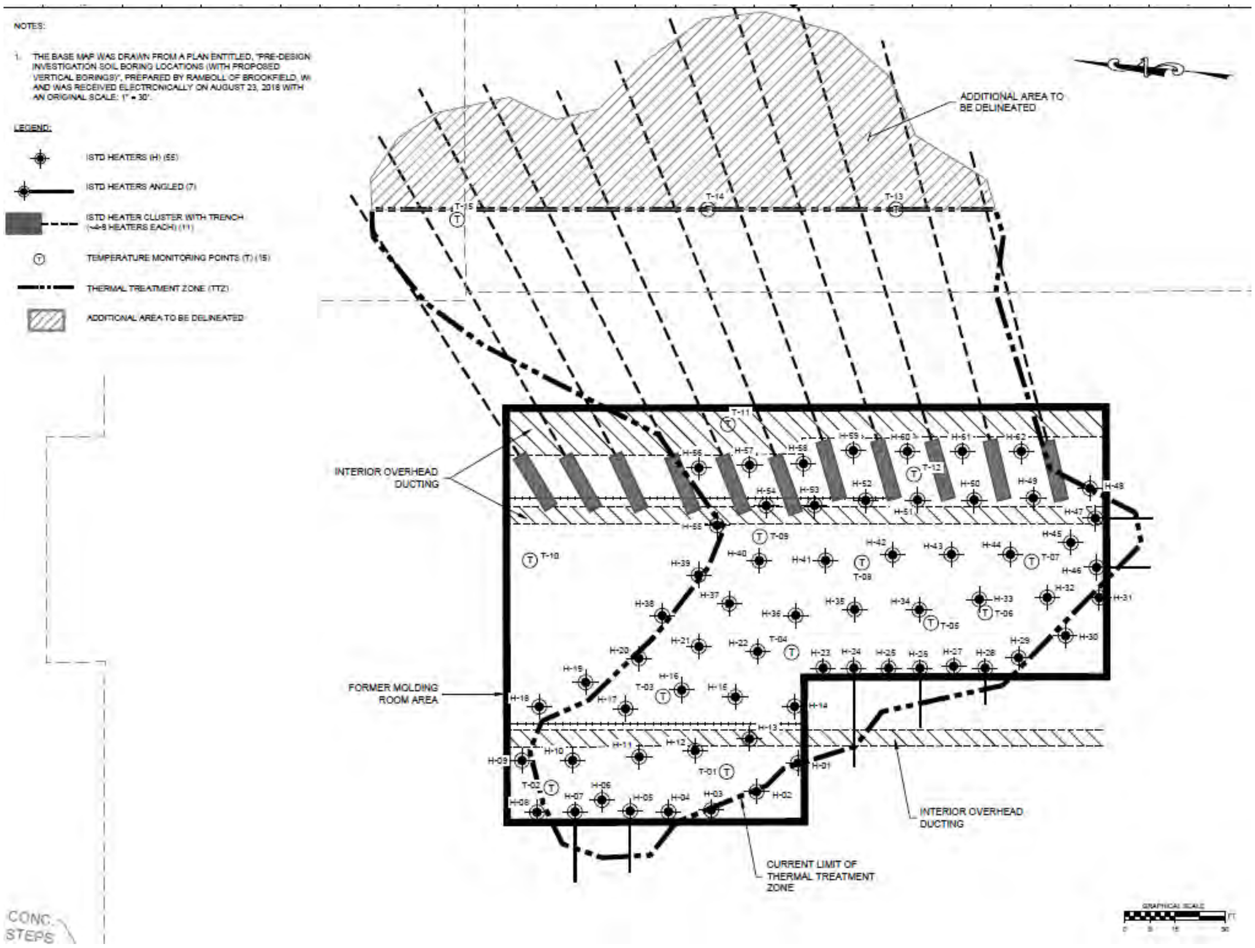


Figure 3.1 – Thermal Treatment Area in the Numerical Simulation and Location of Heater borings, and Temperature Monitoring Points.

The heaters are shown to extend into the eastern area (to the top of the drawing) – the distance is to be defined by additional soil sampling. To offset heat losses, heaters extend at least 5 ft beyond the boundary of the TTZ (above and below the treatment zone) with an additional 1-2 ft of room for thermal expansion at the bottom. A conceptual cross-section of the treatment area is shown in **Figure 3.2**.

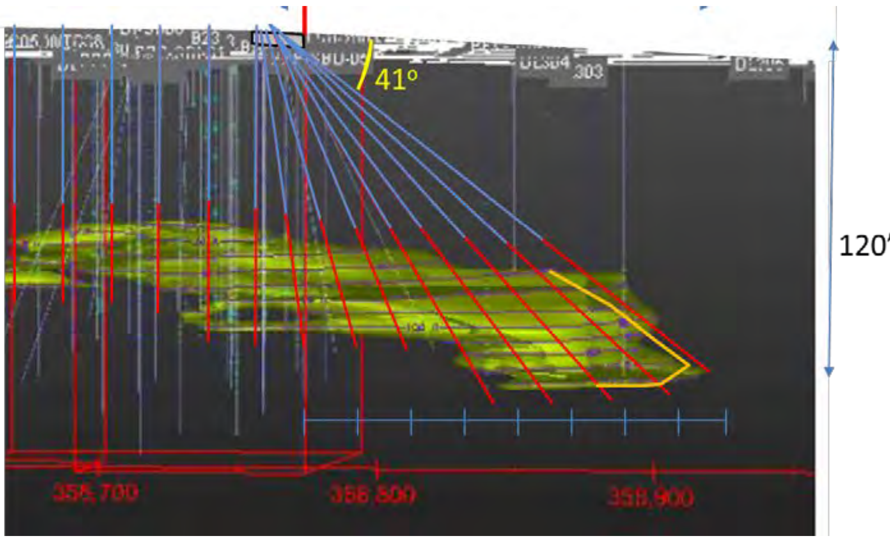


Figure 3.2 – Treatment Depth and ISTD Heating Method in the Target Treatment Zone

Since the TTZ boundaries vary across the site, the numerical model has been simplified to represent average conditions, based on overall heated thickness for the site.

Though the target treatment volume is 17,000cy, the actual volume of soil treated when considering the length of the heaters necessary to treat the target volume is 27,200cy. Using the volume calculated from heater length yields a more accurate model in terms of power and duration estimates, because it takes into consideration the design of the heaters used to treat the target volume rather than just the surgical target volume calculated based on the "green blob".

The Heated Zone (HZ), where heat is applied, that includes the 5ft heater stick-down and stick-up, includes a total volume of 35,928cy.

3.1 Numerical Calculations

In the numerical model, the volume was divided into 9 layers based on the treatment area and volume, the predominant geological properties present at the site and the contaminant distribution. Layers 5 through 7 in the model are all within the TTZ, while the remaining layers are outside of the TTZ. Layers and geology defined in the numerical model are shown in **Figure 3.3**.

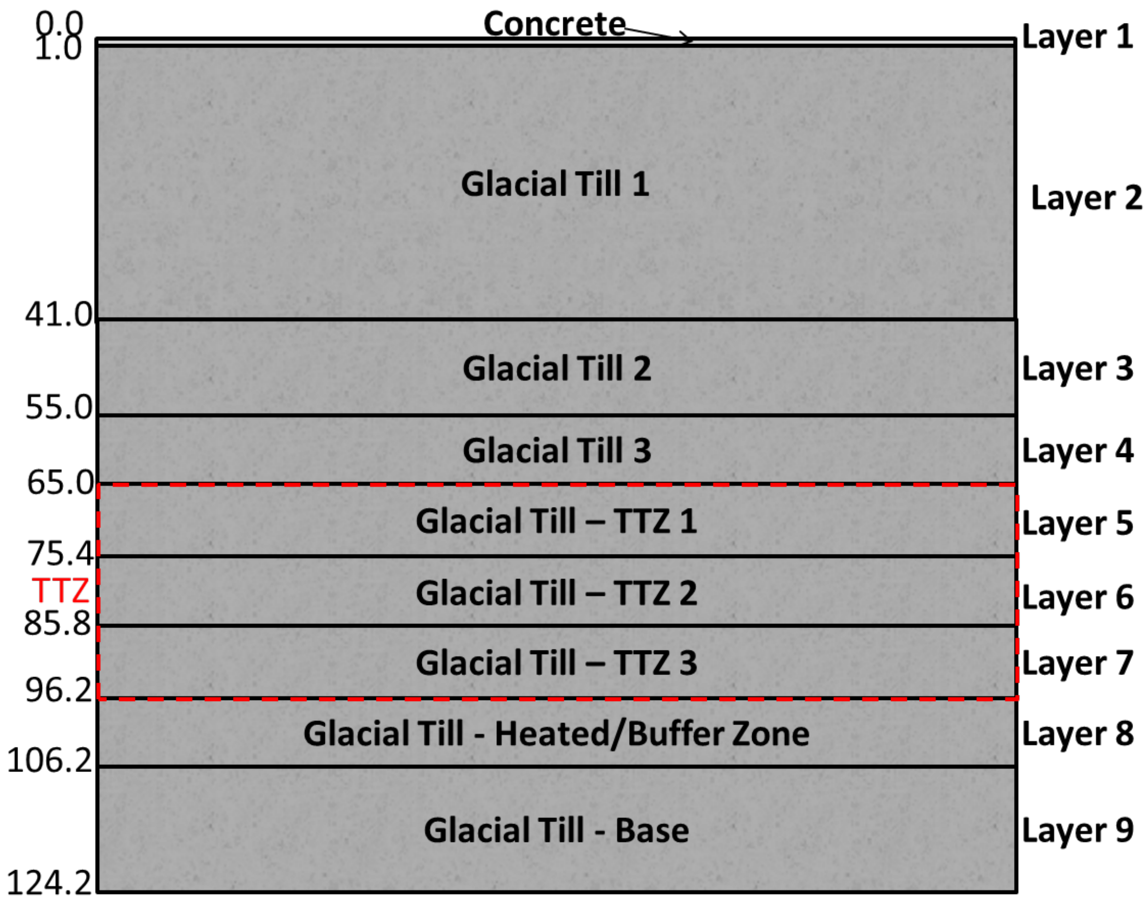


Figure 3.3 – Numerical Model Layers

3.2 Input parameters

Input values of porosity and initial saturation for the model layers appear in **Table 3.1**. These values serve as the starting basis for the energy balance calculations conducted in the model. The Glacial Till - Heated/Buffer Zone is 10ft thick in the model but the heated zone only incorporates the upper 5ft of that layer. When configuring the power input, it was assumed that only half of the Heated/Buffer Zone layer received power from heaters.

Table 3.1 – Porosity and Initial Saturation for Each Layer.

Layer	Geology	Top [ft bgs]	Bottom [ft bgs]	Thickness [ft]	Porosity [-]	Initial saturation [-]	Ambient temperature [°C]
Layer 1	Concrete	0.0	1.0	1.0	0.4	0.1	10
Layer 2	Glacial Till 1	1.0	41.0	40.0	0.4	0.5	10
Layer 3	Glacial Till 2	41.0	55.0	14.0	0.4	0.6	10
Layer 4	Glacial Till 3	55.0	65.0	10.0	0.4	0.7	10
Layer 5	Glacial Till – TTZ 1	65.0	75.4	10.4	0.4	0.7	10
Layer 6	Glacial Till – TTZ 2	75.4	85.8	10.4	0.4	0.7	10
Layer 7	Glacial Till – TTZ 3	85.8	96.2	10.4	0.4	0.7	10
Layer 8	Glacial Till - Heated/Buffer Zone	96.2	106.2	10.0	0.4	0.75	10
Layer 9	Glacial Till - Base	106.2	124.2	18.0	0.4	0.98	10

3.3 Energy Balance

Tabe 3.2 and **Table 3.3** provide a summary of the heat capacity in the modeled zones and a summary of the model energy balance calculations.

Table 3.2 – Volume and Heat Capacity

Volume and Heat Capacity		
Total volume, TTZ	27,200	cy
Total volume, HZ	35,928	cy
Solids volume, HZ	21,557	cy
Air volume, HZ	4,311	cy
Water volume, HZ	10,060	cy
Soil weight, HZ	96,202,000	lbs soil
Water weight, HZ	16,941,000	lbs water
Soil heat capacity, HZ	24,051,000	BTU/°F
Water heat capacity, HZ	16,941,000	BTU/°F
Total heat capacity, HZ	40,992,000	BTU/°F

The volume of the TTZ in the model is 27,200 cy, however the heated volume (HZ) includes 5 ft stick-out from top and bottom of the TTZ and therefore a total of 35,928 cy. The total heat capacity of the heated volume is 40,992,000 BTU/°F.

Table 3.3 shows the energy added to the TTZ by the thermal conduction heaters, the energy removed from the TTZ as steam by the vapor extraction systems, and the estimated energy losses through the top, bottom and sides of the TTZ.

Table 3.1 – Energy Balance (average values)

Energy balance	Energy
	[kW]
TCH power input rate, average	1,387
Steam energy removal, average	340
Heat loss top, average	23
Heat loss bottom, average	108
Heat loss sides, average	374
Net energy injection	542

3.4 Temperature Progression

Figure 3.4 shows the predicted average temperature in the model layers as a function of time. Based on the energy calculations, the predicted total duration of the remedy is estimated to be 256 days.

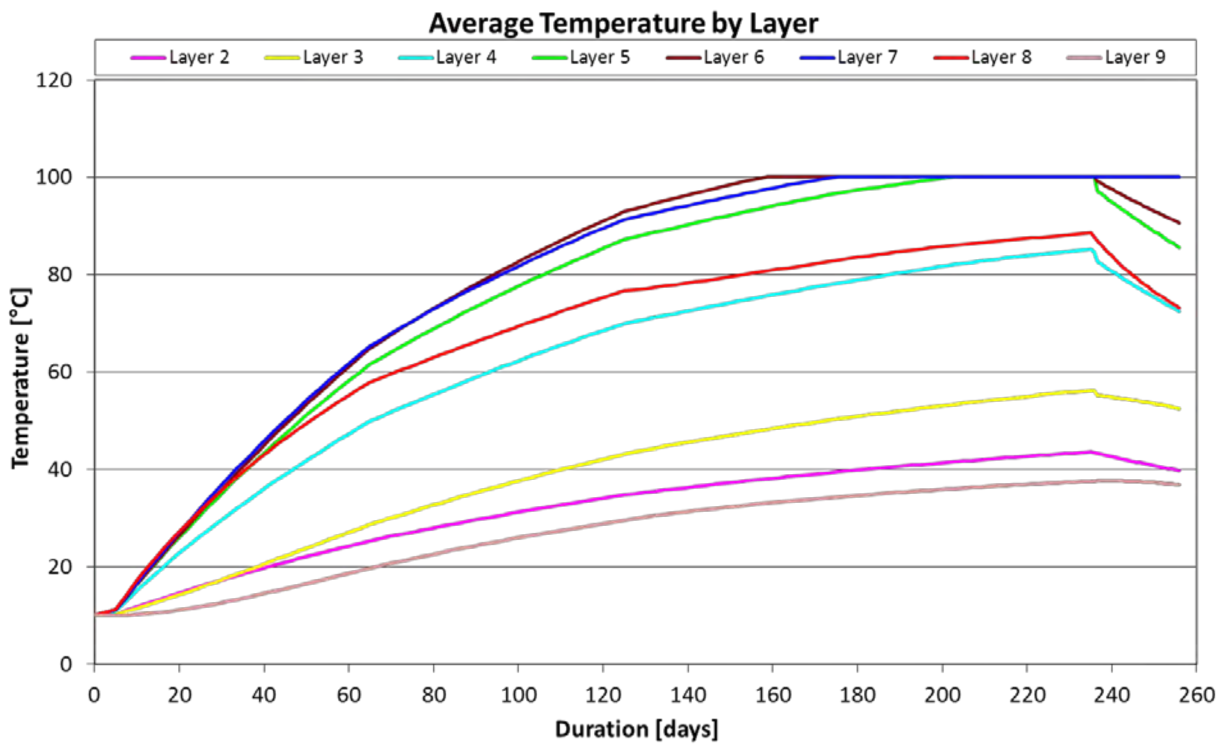


Figure 3.4 – Average Temperature Curves for Layer 2 to Layer 9 during Thermal Treatment[1]

[1] Note: Layers 1-4 are above the TTZ, Layers 5-7 are within the TTZ and Layers 8 and 9 are below the TTZ.

The results of the simulation indicate that the entire TTZ (layers 5 through 7) reaches a temperature of the boiling point of water after approximately 156 to 201 days of operation.

The following **Figure 3.5** shows the development of the temperature in depth profiles at different operational periods. Note that target temperatures on an average basis are approached around day 185 of operation and maintained for approximately 50 days.

The heating which occurs at shallower depths stem from energy released from the upper segments of the heaters, the so-called "cold-pin". These sections of the heaters consist of a nickel rod with much lower resistance than the stainless steel, but some energy is still released (on the order of 5-7 times less per linear ft than the heater sections).

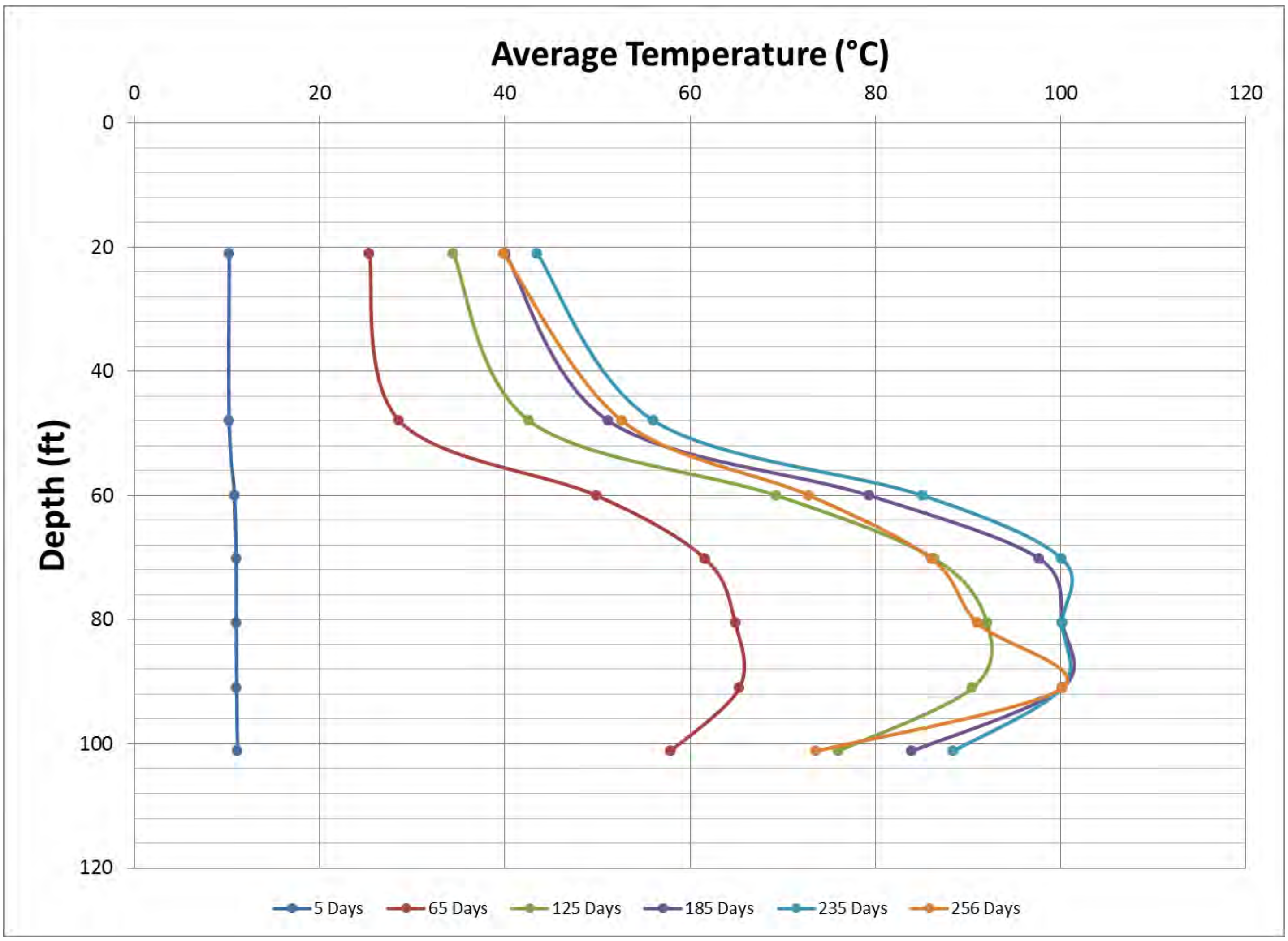


Figure 3.5 – Predicted Vertical Temperature Profiles

3.5 Energy Demand

The numerical energy balance calculation accounts for the following:

- Energy input by the electrical heaters
- Delivery efficiency of the electrical heaters
- Heat losses to the surrounding areas (sides and through top and bottom of the TTZ)
- Removal of energy from the site by extraction of heated air and steam.
- Removal of energy from the site by extraction of heated groundwater.

Table 3.5 summarizes the power usage by the ISTD subsurface system throughout the duration of the thermal treatment system operation.

Table 3.2 – Power Usage for Heating

Power usage	Duration [Days]	Power Usage ISTD [kWh]
Period 1	5	31,000
Period 2	60	2,263,000
Period 3	60	2,074,000
Period 4	60	1,886,000
Period 5	50	1,571,000
Period 6	21	0
Total	256	7,825,000

Based on the numerical calculations, it is estimated that a total of approximately 7.9 million kWh of electricity will be injected into the subsurface. The power demand of the effluent treatment system is not included in this estimate.

The estimated total period of TCH operations is approximately 256 days (~8.5 months), including 21 days of post-treatment vapor extraction and initial cool-down. The operational plan is flexible, allowing for adjustments based on observed hydraulic responses, heating progression, and contaminant extraction rates.

APPENDIX B

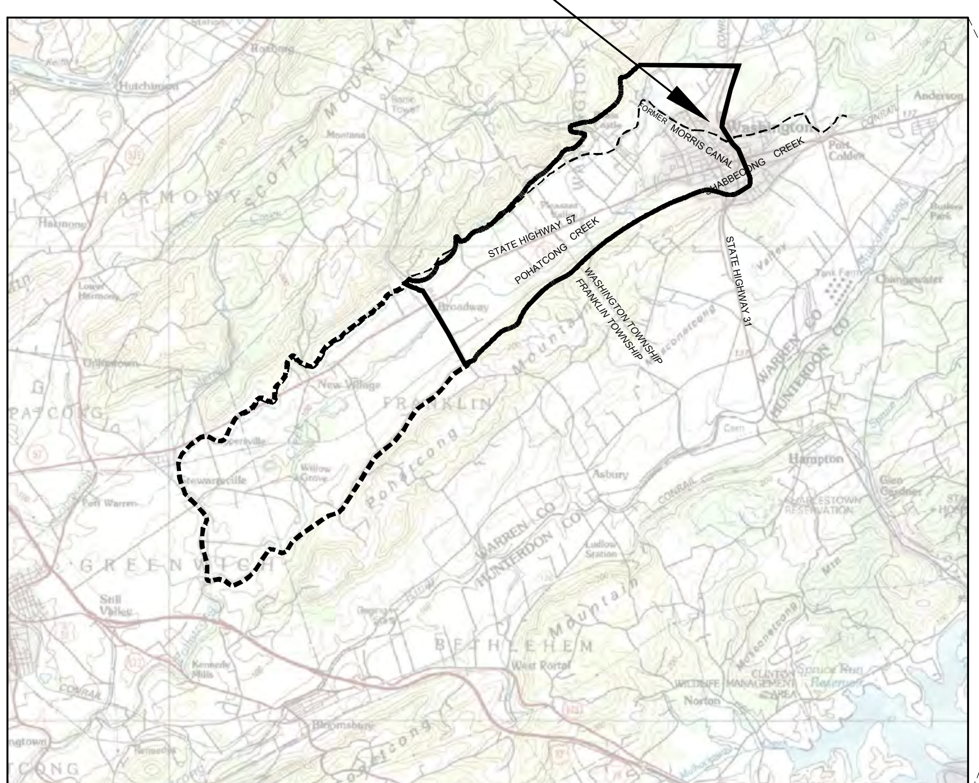
PRELIMINARY DESIGN DRAWINGS

PRELIMINARY (30%) DESIGN
IN SITU THERMAL REMEDIATION SYSTEM
OPERABLE UNIT 3 POHATCONG VALLEY GROUNDWATER CONTAMINATION SUPERFUND SITE, WARREN COUNTY, NEW JERSEY SEPTEMBER 2018

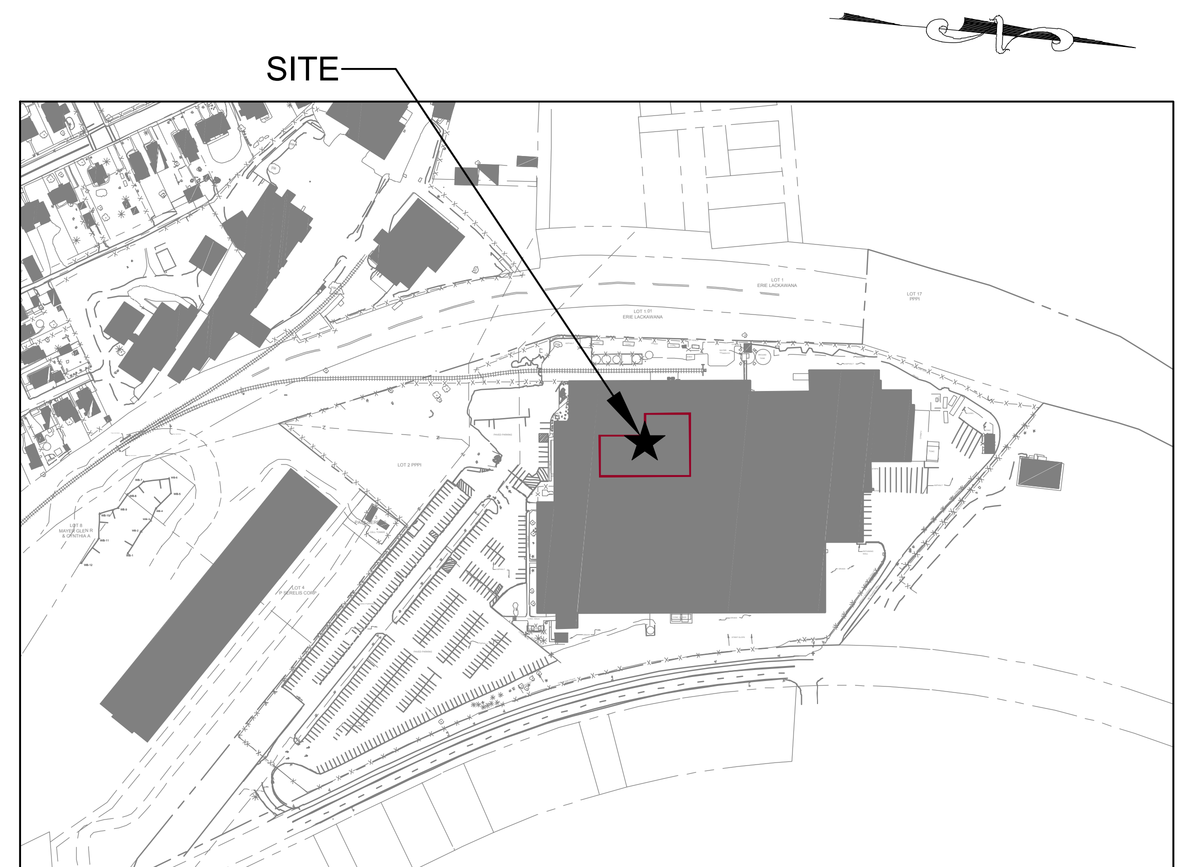
DRAFT

DRAWING INDEX

APPROXIMATE TREATMENT AREA



SITE



REV	DATE	CAD	ENG	DL	DESCRIPTION	CM	PM
C	9/27/2018	CN			REVISED 30% DESIGN DRAFT PER CLIENT COMMENTS		DP
B	8/31/2018	RH	DB		REVISED 30% DESIGN PER CLIENT COMMENTS		DP
A	8/24/2018	TJM	DB		30% DESIGN SUBMITTAL		DP

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PRELIMINARY (30%) DESIGN, IN SITU THERMAL REMEDIATION SYSTEM, OU3, PVGCS SITE, WARREN COUNTY, NEW JERSEY

DRAWING INDEX AND LOCATION MAP

SCALE: NTS
SHEET SIZE: D
REV: C
REFERENCE NO.:
SHEET: 1 OF 1
DWG NO.: CS-1

PLOT DATE: 9/28/2018

DRAFT

NOTES:

1. PROJECTED THERMAL TREATMENT ZONE TO BE VERIFIED BY SUPPLEMENTAL SOIL BORINGS TO BE INSTALLED DURING THE SCHEDULED PLANT SHUT DOWN ON DECEMBER 24, 2018 THROUGH JANUARY 1, 2019.
2. THERMAL TREATMENT ZONE CONFIRMED BY PRE-DESIGN INVESTIGATION SOIL BORING ACTIVITIES COMPLETED THROUGH AUGUST 2018.
3. TOTAL VOLUME OF PROJECTED AND CONFIRMED THERMAL TREATMENT ZONES IS 17,000 CUBIC YARDS.
4. ALL SITE FEATURES ARE APPROXIMATE, ADDITIONAL SITE FEATURES MAY BE PRESENT.
5. THIS DRAWING HAS BEEN PREPARED, IN PART BASED UPON INFORMATION FURNISHED BY OTHERS* WHILE THIS INFORMATION IS BELIEVED TO BE RELIABLE, THE ENGINEER ASSUMES NO RESPONSIBILITY FOR THE ACCURACY OF THIS DRAWING OR FOR ANY ERRORS OR OMISSIONS THAT MAY HAVE BEEN INCORPORATED INTO IT AS A RESULT OF INCORRECT INFORMATION PROVIDED TO THE ENGINEER. THOSE RELYING ON THIS DOCUMENT ARE ADVISED TO OBTAIN INDEPENDENT VERIFICATION OF ITS ACCURACY.

*SOURCES:

1. PRE-CONSTRUCTION SITE FEATURES, TOPOGRAPHY, AND UTILITIES; A PLAN ENTITLED "EXISTING CONDITIONS AND SURVEY CONTROLS" PREPARED BY GEOD CORP. DATED 02/22/11 AND REVISED THROUGH 04/27/2015.
2. LOT LINES: TAKEN FROM MOST RECENT TAX MAPS AND REALQUEST.COM (NOT SURVEYED)
3. SURFACE ELEVATIONS PROVIDED BY LAYOUT, INC.

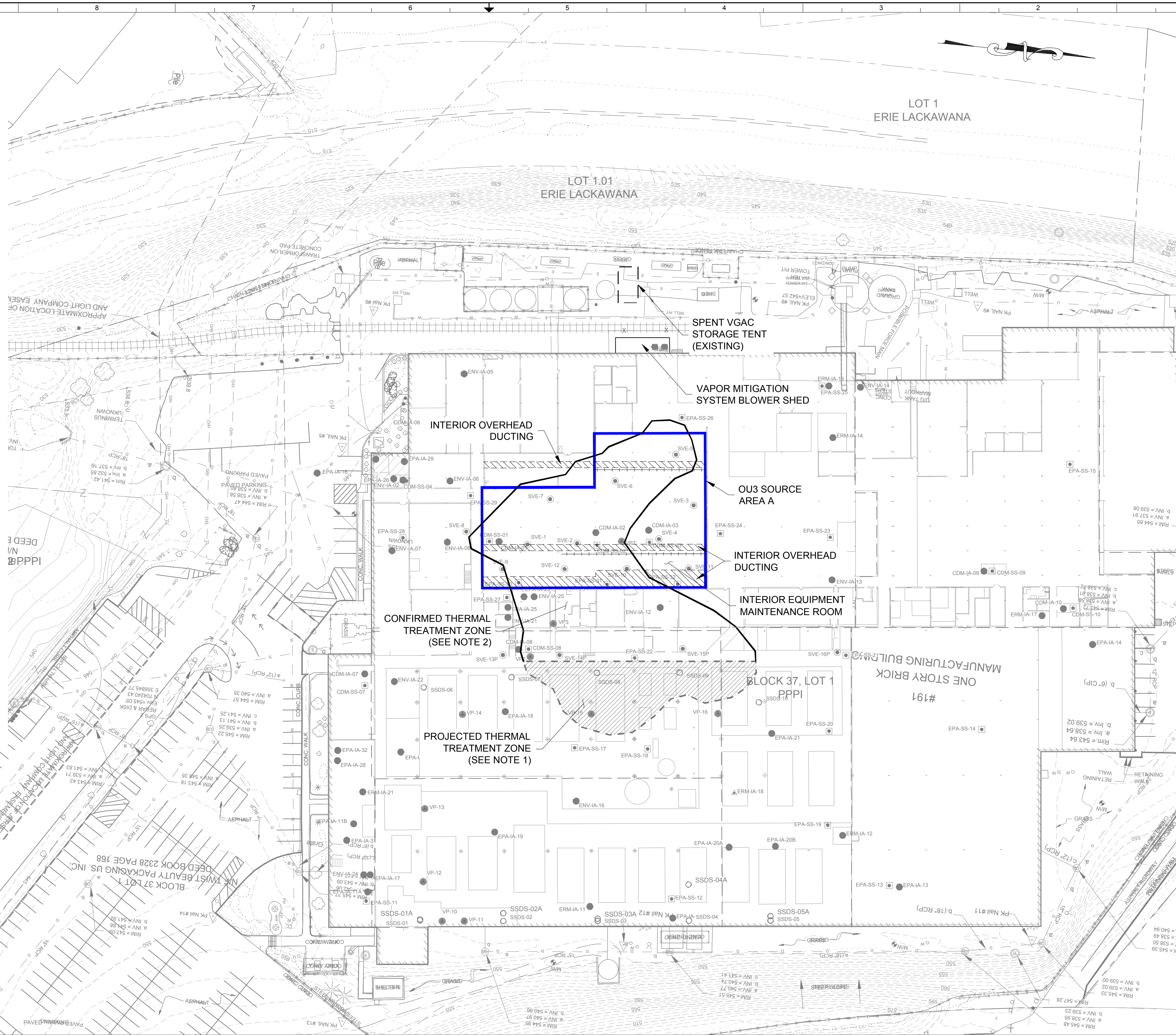
LEGEND:

THERMAL TREATMENT ZONE (TTZ)

SIGN SINGLE POST
SIGN DOUBLE POST
SMALL DECIDUOUS TREE 8" OR SMALLER
MEDIUM DECIDUOUS TREE 8" TO 18"
LARGE DECIDUOUS TREE 18" OR LARGER
BUSH OR SHRUB
MEDIUM CONIFEROUS TREE 8" TO 18"
LARGE CONIFEROUS TREE 18" OR LARGER
MONITORING WELL
GAS VALVE
TRASH BARREL
LARGE ROCK / BOULDER
DOUBLE LIGHT POLE
UNKNOWN VALVE
WOOD UTILITY POLE
FENCE POST
FLAG POLE
ELECTRIC BOX RECTANGULAR
GUY WIRE
METAL LIGHT POLE
FIRE CALL BOX
EPA-SS-13 SUB SLAB VAPOR MONITORING POINT (INSTALLED BY OTHERS)
VP1 SUB SLAB VAPOR MONITORING POINT (INSTALLED BY ENVIRON)
SVE-4 SVE SHALLOW EXTRACTION POINT (INTERIM)
SVE-11 SVE EXTRACTION POINT
SSDS-04 SUB SLAB DEPRESSURIZATION EXTRACTION POINT

TRAVERSE
WATER MANHOLE
WATER VALVE
WATER VALVE
ELECTRIC MANHOLE
PROTECTIVE POST
DOUBLE CATCH BASIN
SP STAND PIPE
UNKNOWN MANHOLE
GAS LINE
WATER LINE
ELECTRIC LINE
DRAINAGE LINE
SANITARY LINE
CHAIN LINK FENCE LINE
BUILDING LINE
BOTTOM SLOPE LINE
METAL GUIDERAIL

GRAPHICAL SCALE
0 20 40 80 FT



REV	DATE	CAD	ENG	DL	DESCRIPTION	CM	PM
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B	8/31/2018	RH	DB		REVISED 30% DESIGN PER CLIENT COMMENTS		DP
A	8/24/2018	TJM	DB		30% DESIGN SUBMITTAL		DP

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PRELIMINARY (30%) DESIGN, IN SITU THERMAL REMEDIATION SYSTEM, OU3, PVGCS SITE, WARREN COUNTY, NEW JERSEY

EXISTING CONDITIONS PLAN

SCALE: NTS
SHEET SIZE: D
REV: C
REFERENCE NO.:
SHEET: 1 OF 1
DWG NO.: C101

PLOT DATE: 9/28/2018

FILE: J:_PROJECTS\RAMBOLL - WASHINGTON NJ\01-DESIGN\001-DRAWINGS\0001-IN-PROGRESS DWGS\C101-EXISTING CONDITIONS PLAN.DWG
CTB FILE: TT-STANDARD.CTB

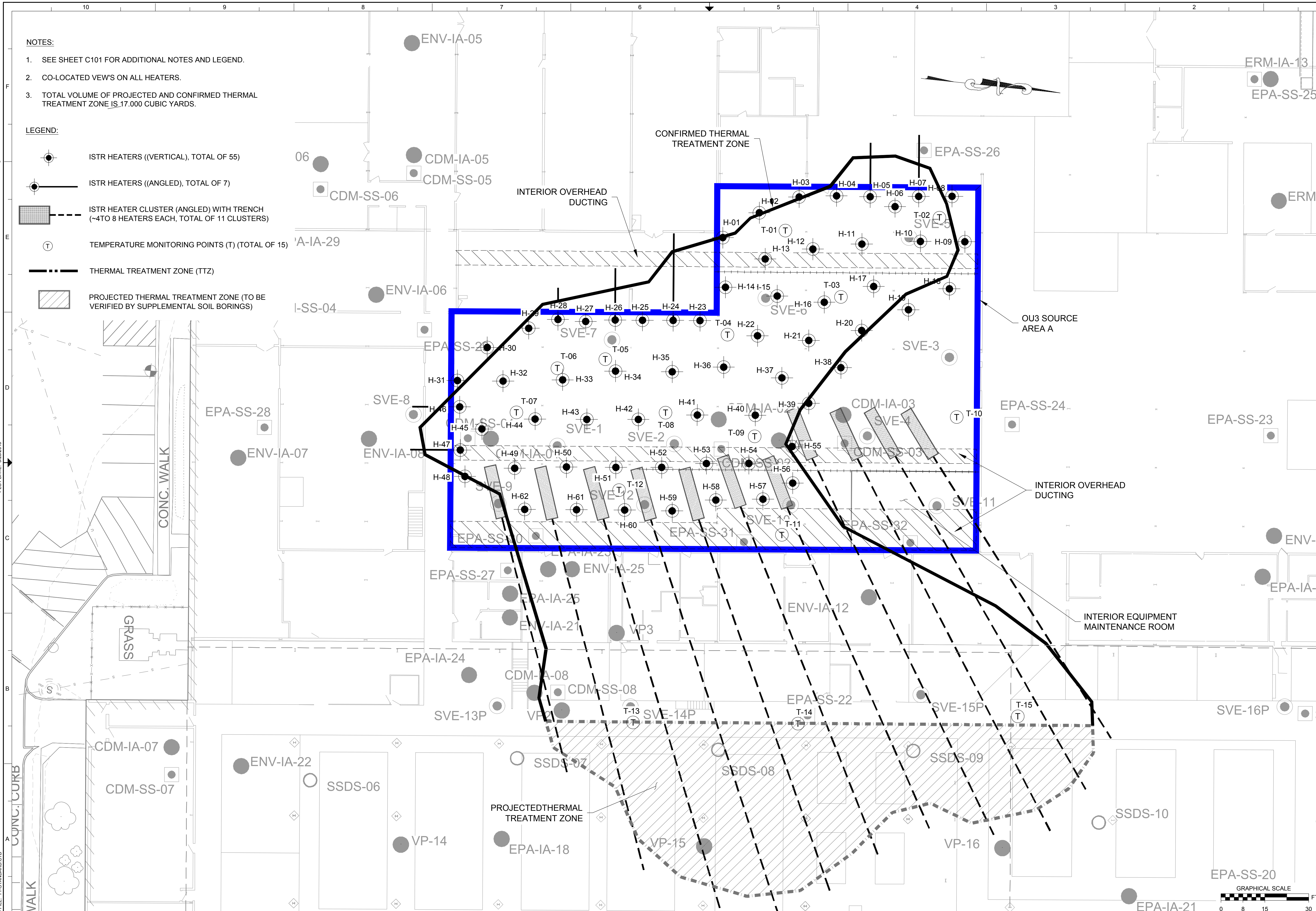
DRAFT

NOTES:

1. SEE SHEET C101 FOR ADDITIONAL NOTES AND LEGEND.
2. CO-LOCATED VEW'S ON ALL HEATERS.
3. TOTAL VOLUME OF PROJECTED AND CONFIRMED THERMAL TREATMENT ZONE IS 17,000 CUBIC YARDS.

LEGEND:

- ISTR HEATERS ((VERTICAL), TOTAL OF 55)
- ISTR HEATERS ((ANGLED), TOTAL OF 7)
- ISTR HEATER CLUSTER (ANGLED) WITH TRENCH (~4TO 8 HEATERS EACH, TOTAL OF 11 CLUSTERS)
- TEMPERATURE MONITORING POINTS (T) (TOTAL OF 15)
- THERMAL TREATMENT ZONE (TTZ)
- PROJECTED THERMAL TREATMENT ZONE (TO BE VERIFIED BY SUPPLEMENTAL SOIL BORINGS)



PRELIMINARY (30%) DESIGN, IN SITU THERMAL REMEDIATION SYSTEM, OU3, PVGCS SITE, WARREN COUNTY, NEW JERSEY

WELLFIELD LAYOUT

REV	DATE	CAD	ENG	DL	DESCRIPTION	CM	PM
C	9/28/2018	CN			REVISED 30% DESIGN DRAFT PER CLIENT COMMENTS		DP
B	8/29/2018	RH	DB		REVISED 30% DESIGN PER CLIENT COMMENTS		DP
A	8/24/2018	TJM	DB		30% DESIGN SUBMITTAL		DP

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SCALE: NTS
SHEET SIZE: D
REV: C
REFERENCE NO.:
SHEET: 1 OF 1
DWG NO.: C102

ELECTRICAL ONELINE LEGEND (SMART SYMBOL)

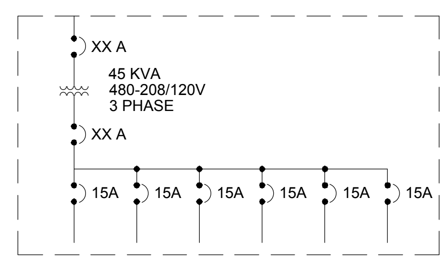
TERRATHERM FREQUENTLY USED TERMS AND SYMBOLS

A	- AMPERE
AMP	- AMPERE
ATS	- AUTOMATIC TRANSFER SWITCH
C.S.	- CARBON STEEL
DP	- DISTRIBUTION PANEL
FLA	- FULL LOAD AMPS. MOTOR FLA ARE SPECIFIED PER NEC 430.250
GFCI	- GROUND FAULT CIRCUIT INTERRUPTER
KVA	- KILOVOLT-AMPERE
KW	- KILOWATTS
KWHR	- KILOWATT-HOUR
LC	- LOAD CENTER
LCP	- LOCAL CONTROL PANEL
MSWB	- MAIN SWITCHBOARD
OWS	- OIL WATER SEPARATOR
SCR	- SILICON CONTROLLED RECTIFIER
T(XXX)	- TERRATHERM EQUIPMENT IDENTIFICATION NUMBER
V	- VOLTS
VFD	- VARIABLE FREQUENCY DRIVE
XX/XXX	- PLACE HOLDER - INFORMATION TO BE ADDED FOR SPECIFIC PROJECT

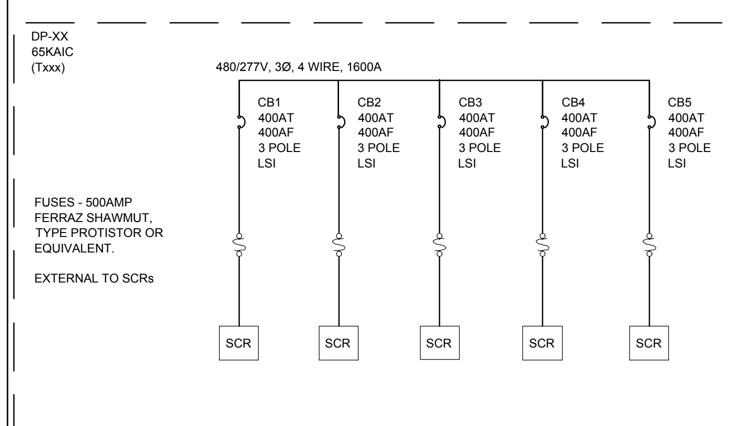
Symbol	Description
	WIRE TERMINATION / CONNECTION POINT
	ELECTRICAL CONDUCTOR / WIRE
	SEMI-CONDUCTOR FUSE
X	HEATER ELEMENT AS REPRESENTED IN ONELINE. LETTER IN HEXAGON DENOTES HEATER TYPE.
	HEAT TRACE FOR PIPING
XX	DISCONNECT SWITCH RATING AS NOTED
VFD	VARIABLE FREQUENCY DRIVE (VFD)
XX / FLA XXX	MOTOR. HORSEPOWER AS INDICATED IN CIRCLE. FULL LOAD AMPS (FLA) AS NOTED PER APPLICABLE NEC TABLE.
MS	MOTOR STARTER
XX KW	STANDBY GENERATOR. KW RATING AS NOTED.
XXX : XXX V	VOLTAGE TRANSFORMER, TYPICALLY USED FOR METERING. VOLTAGE RATIO AS NOTED.
XXX : 5 A	CURRENT TRANSFORMER, TYPICALLY USED FOR METERING. CURRENT TRANSFORMER RATIO AND POLARITY AS NOTED.
M~	ENERGY METER (KWHR) MODEL AS NOTED
KVA / PRI_VOLT : 480/277V / %z	POWER TRANSFORMER WITH PRIMARY VOLTS, SECONDARY VOLTS, KVA RATINGS, AND % IMPEDANCE AS NOTED
	EQUIPMENT SKID BOUNDARY
ATS-1 / XXX A / N / E / L	AUTOMATIC TRANSFER SWITCH. SWITCH AMP RATING AS NOTED
RATED HP @460V / FLA X - X / XX AMPS MAX	UL COMBINATION STARTER TYPE E, SELF-PROTECTED OR TYPE F. FULL LOAD AMP RATING ADJUSTABLE IN SPECIFIED RANGE.

ELECTRICAL ONELINE LEGEND (SMART SYMBOL - INTEGRATED EQUIPMENT)

Symbol	Description
CB # / AMP / 3 POLES	LOW VOLTAGE AIR CIRCUIT BREAKER WITH RATING AND NUMBER OF POLES AS NOTED. NON-ADJUSTABLE TYPE.
CB # / XX AT / XX AF / 3 POLES	LOW VOLTAGE AIR CIRCUIT BREAKER WITH RATING AND NUMBER OF POLES AS NOTED. TRIP RATING ADJUSTABLE TYPE.
CB # / XX AT / XX AF / 3 POLES / LSIG	LOW VOLTAGE AIR CIRCUIT BREAKER WITH RATING AND NUMBER OF POLES AS NOTED. TRIP RATING ADJUSTABLE TYPE. PROTECTION TO BE SPECIFIED AS REQUIRED.
CB # / XX AT / XX AF / 3 POLES / LSIG	LOW VOLTAGE AIR CIRCUIT BREAKER WITH RATING AND NUMBER OF POLES AS NOTED. TRIP RATING ADJUSTABLE TYPE. PROTECTION TO BE SPECIFIED AS REQUIRED. DRAWOUT TYPE.
CB # / XX AT / XX AF / 3 POLES / LSIG	MEDIUM VOLTAGE VACUUM CIRCUIT BREAKER WITH RATING AND NUMBER OF POLES AS NOTED. TRIP RATING ADJUSTABLE. PROTECTION TO BE SPECIFIED AS REQUIRED. DRAWOUT TYPE.
XXX AMP FUSE / TYPE	FUSE RATING AND TYPE AS NOTED.
XXX A - SWITCH / XXX AMP FUSE / FUSE_TYPE	FUSED DISCONNECT SWITCH WITH SWITCH RATING, FUSE RATING AND TYPE AS NOTED.



INTEGRATED PANEL WITH TRANSFORMER ASSEMBLY. PRIMARY AND SECONDARY BREAKERS AS NOTED. DISTRIBUTION PANEL CONTAINS BREAKERS AS NOTED.

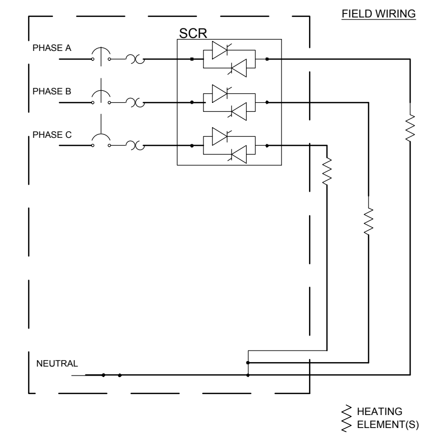


INTEGRATED DISTRIBUTION PANEL WITH BUILT-IN SCR CABINETS / ZONES. EACH ZONE HAS CUSTOMIZABLE PROTECTION FOR THE HEATER CIRCUIT AND THE SCR.

SCR POWER WIRING SCHEMATICS

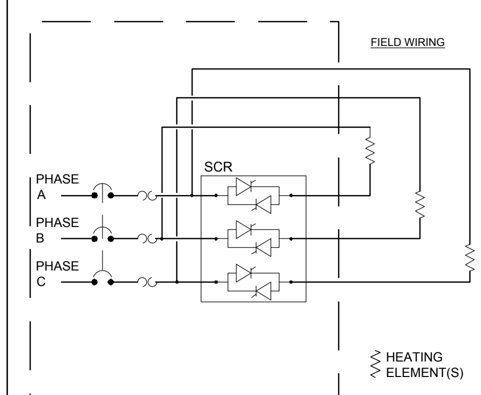
HEATER CIRCUIT - WYE CONFIGURED, 277V

HEATER CIRCUIT - WYE CONFIGURED, 277V, TYPICAL WIRING WITHIN INTEGRATED SCR CABINET



HEATER CIRCUIT - INSIDE DELTA CONFIGURED, 480V

HEATER CIRCUIT - DELTA CONFIGURED, 480V, TYPICAL WIRING WITHIN INTEGRATED SCR CABINET



ELECTRICAL WIRE LAYOUT SYMBOLS

Symbol	Description
GFCI	GROUND FAULT CIRCUIT INTERRUPTER (GFCI) DUPLEX OUTLET WITH WEATHERPROOF COVER.
ES	EMERGENCY STOP - PUSHBUTTON STATION
GFCI	OUTDOOR LIGHTING WITH GFCI DUPLEX RECEPTACLE IN WEATHERPROOF COVER
ES GFCI	OUTDOOR LIGHTING WITH GFCI DUPLEX RECEPTACLE AND E-STOP ON SHARED POLE

GENERAL NOTES

THE FOLLOWING NOTES ARE APPLICABLE TO ALL ELECTRICAL DRAWINGS, OR E-SERIES, UNLESS SPECIFICALLY STATED OTHERWISE ON THE SPECIFIC DRAWING. THE FOLLOWING IS NOT AN ALL-INCLUSIVE LIST OF RELEVANT CODE APPLICABLE TO THIS PROJECT BUT IS INTENDED TO HIGHLIGHT THE MAJOR SECTIONS ONLY.

GENERAL NOTES:

1. CASCADE THERMAL WILL PROVIDE ALL FLEXIBLE CORDS AND CONNECTORS FOR EQUIPMENT SHOWN ON DRAWING. CONTRACTOR MAY BE REQUESTED TO PROVIDE ADDITIONAL MATERIAL ON A T&M BASIS AS SITE CONDITION CHANGES.
2. CASCADE THERMAL'S ELECTRICAL DESIGNS ARE BASED ON ARTICLE 590, TEMPORARY INSTALLATION, OF THE NATIONAL ELECTRIC CODE, 2017. ALL TEMPORARY WIRING AND EQUIPMENT WILL BE REMOVED AT THE CONCLUSION OF THE PROJECT. ALL CABLE SHALL BE LISTED FOR HARD OR EXTRA-HARD USAGE PER ARTICLE REQUIREMENT.
3. TYPE "W" AND TYPE "G-GC" ARE CLASSIFIED FOR EXTRA HARD USAGE PER NEC TABLE 400-4. TYPE "W" AND TYPE "G-GC" CABLE AMPACITY ARE SPECIFIED PER NEC ARTICLE 400-5(A)(2) USING 75 DEGREE C COLUMN F3 FOR THREE-CONDUCTOR (3/C) CABLES. COLUMN D1 IS USED FOR SINGLE-CONDUCTOR (1/C) WHERE THE CONDUCTOR IS NOT IN PHYSICAL CONTACT WITH EACH OTHER.
4. ALL CABLE SHALL BE BOTTOM ENTRY WHEREVER PRACTICAL. PER NEC 110.14, ALL TERMINALS OF EQUIPMENT >100A ARE ASSUMED TO BE 75C RATED UNLESS OTHERWISE NOTED.
5. GROUNDING SHALL BE INSTALLED PER NEC ARTICLE 250 - "GROUNDING AND BONDING FOR ALL EQUIPMENT". ROUTE ALL HEATER CIRCUIT EQUIPMENT GROUNDS WITH THE HEATER CIRCUIT CONDUCTORS TO EACH WELLHEAD. REFERENCE TYPICAL GROUNDING DETAILS FOR ADDITIONAL INFORMATION.
6. THE GROUNDING ELECTRODE CONDUCTOR FOR A SEPARATELY DERIVED SYSTEM (TRANSFORMER) SHALL BE INSTALLED AT THE FIRST DISCONNECTING MEAN PER NEC ARTICLE 250.30.
7. GENERATOR SHALL BE WIRED PER NEC ARTICLE 702, OPTIONAL STANDBY SYSTEMS. THE GENERATOR WILL BE WIRED TO A THREE (3) POLE TYPE AUTOMATIC TRANSFER SWITCH (ATS) AND SHOULD BE WIRED AS A NON-SEPARATELY DERIVED SYSTEM, I.E. DO NOT BOND NEUTRAL AT GENERATOR. WIRE EMERGENCY STOP SIGNAL TO PREVENT GENERATOR START DURING AN EMERGENCY. EMERGENCY STOP SIGNAL SHALL ALSO BE WIRED TO SHUNT TRIP THE MAIN BREAKER(S).
8. MAINTAIN WORKING CLEARANCE PER NEC ARTICLE 110.26 - "SPACES ABOUT ELECTRICAL EQUIPMENT".
9. ALL POWER DISTRIBUTION EQUIPMENT SHALL BE UL LISTED OR CERTIFIED BY A 3RD PARTY NRTL.
10. ALL PROCESS EQUIPMENT CONTROL PANELS SHALL BE BUILT TO APPLICABLE UL STANDARDS SUCH AS UL 508, UL 698. EQUIPMENT MAY BE FIELD EVALUATED BY A NRTL IF THE ABOVE STANDARD IS NOT AVAILABLE.
11. EQUIPMENT WITH "A" AND "B" TAG SUCH AS P-101A AND P-101B ARE NON-COINCIDENTAL LOADS.
12. USE THE FOLLOWING COLOR CODES FOR CONDUCTOR IDENTIFICATION:

	208Y / 120 VOLT	480 / 277 VOLT
PHASE A	BLACK	BROWN
PHASE B	RED	ORANGE
PHASE C	BLUE	YELLOW
NEUTRAL	WHITE	GRAY

13. ALL WORK SHALL CONFORM TO THE LATEST LOCAL, STATE AND FEDERAL REQUIREMENTS AS INTERPRETED BY THE AUTHORITY HAVING JURISDICTION

SITE SPECIFIC NOTES:

1. AMPACITIES OF CABLE ARE CORRECTED FOR AN MAX AMBIENT TEMPERATURE OF 91 DEGREE F
2. THE AVAILABLE FAULT CURRENT IS ASSUMED TO BE < 65KA. EXACT NUMBERS TO BE PROVIDED BY UTILITY

DRAFT

REV	DATE	CAD	ENG	DL	DESCRIPTION	CM	PM
C	9/28/2018	RH	DB		REVISED 30% DESIGN DRAFT PER CLIENT COMMENTS		DP
B	8/31/2018	RH	DB		REVISED 30% DESIGN PER CLIENT COMMENTS		DB
A	8/24/2018	TJM	DB		30% DESIGN SUBMITTAL	CM	DP

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PRELIMINARY (30%) DESIGN, IN SITU THERMAL REMEDIATION SYSTEM, OU3, PVGCS SITE, WARREN COUNTY, NEW JERSEY

ELECTRICAL LEGEND

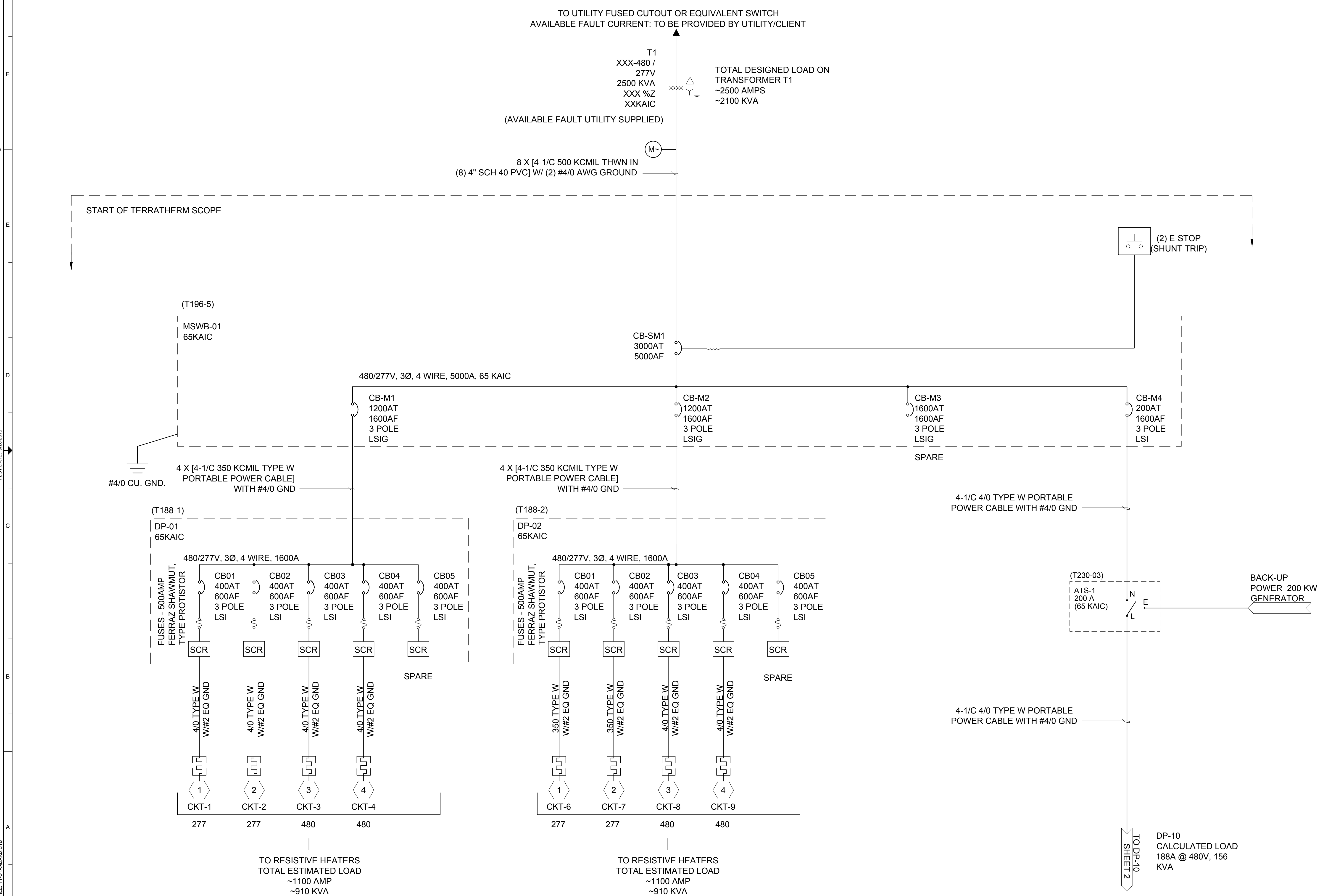
SCALE: NTS
SHEET SIZE: D
REV: C
REFERENCE NO.:
SHEET: 1 OF 1
DWG NO.: E100

PLOT DATE: 9/28/2018

FILE: J:_ROJECTS\RAMBOLL - WASHINGTON NJ\01-DESIGN\001-DRAWINGS\0001-IN-PROGRESS DWGS\E100-ELECTRICAL LEGEND.DWG
CTB FILE: TT-STANDARD.CTB

PLOT DATE: 9/28/2018

DRAFT



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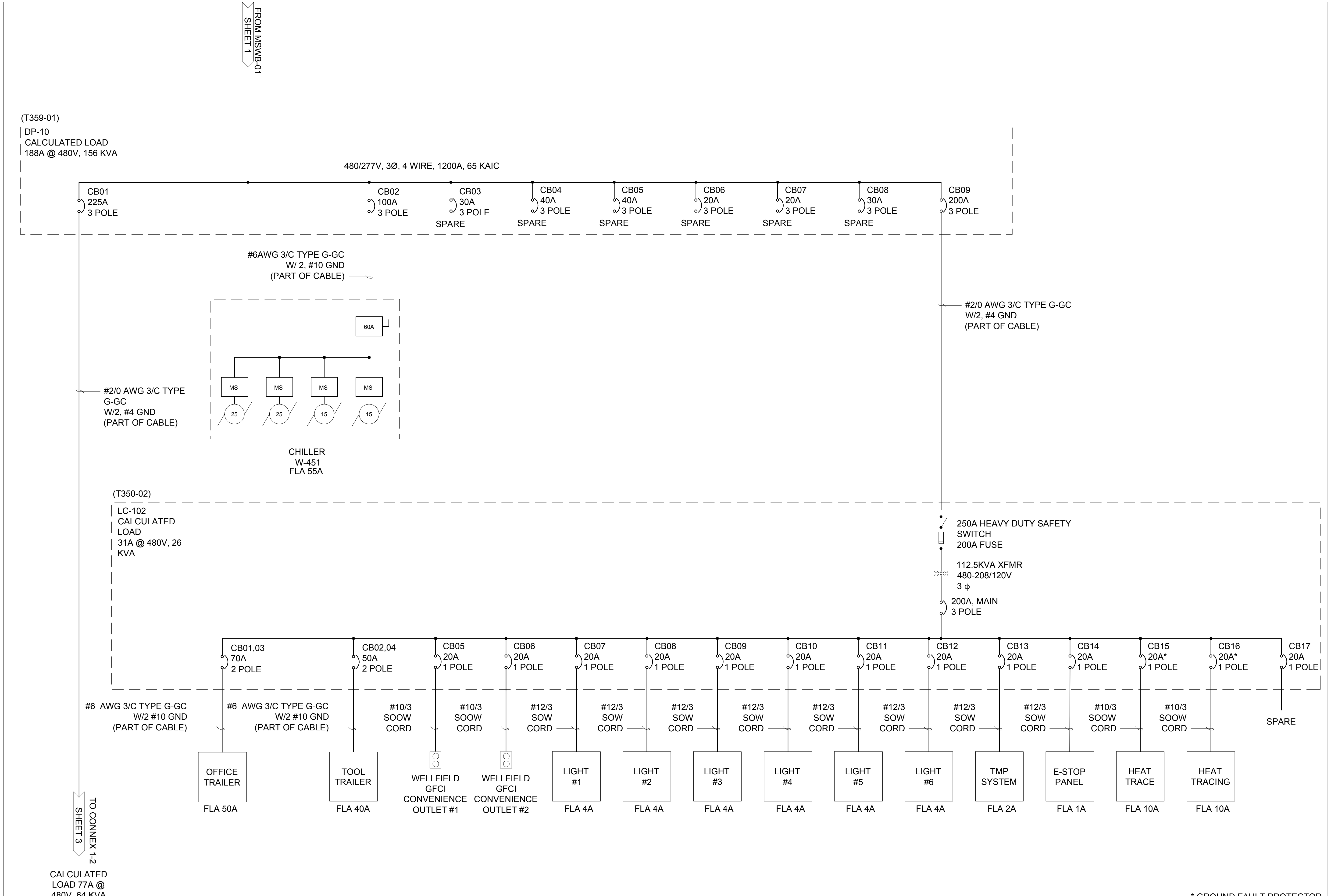
PRELIMINARY (30%) DESIGN, IN SITU THERMAL REMEDIATION SYSTEM, OU3, PVGCS SITE, WARREN COUNTY, NEW JERSEY

ELECTRICAL ONE-LINE DIAGRAM

SCALE: NTS
SHEET SIZE: D
REV: C
REFERENCE NO.:
SHEET: 1 OF 3
DWG NO.: E101



PLOT DATE: 9/28/2018

FILE: J:...ROJECTS\RAMBOLL - WASHINGTON NJ\01-DESIGN\001-DRAWINGS\0001-IN-PROGRESS DWGS\E101-ELECTRICAL ONE-LINE.DWG
CTB FILE: TT-STANDARD.CTB

DRAFT

SEAL

REV	DATE	CAD	ENG	DL	DESCRIPTION	CM	PM
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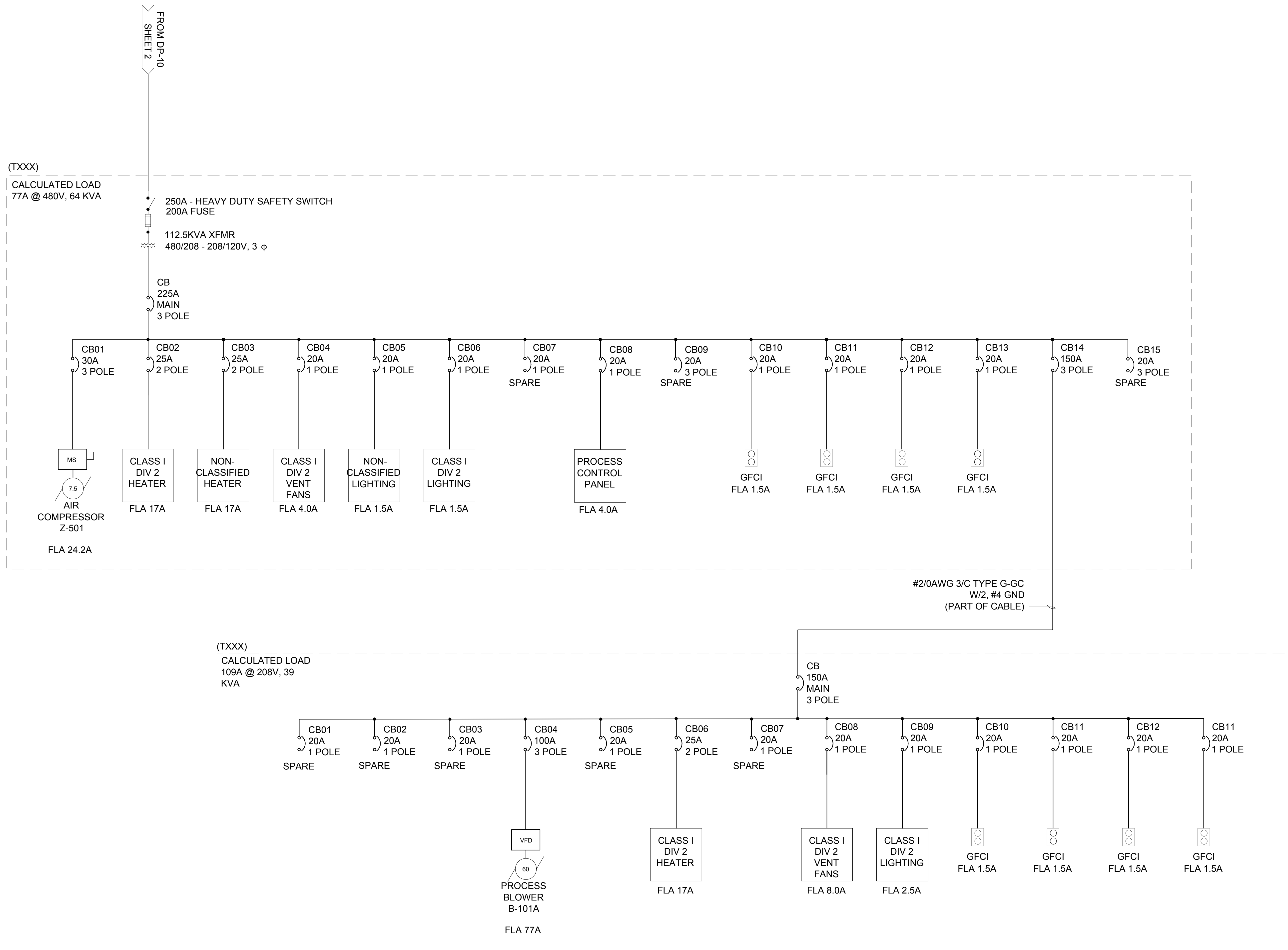
PRELIMINARY (30%) DESIGN, IN SITU THERMAL REMEDIATION SYSTEM, OU3, PVGCS SITE, WARREN COUNTY, NEW JERSEY

ELECTRICAL ONE-LINE DIAGRAM

SCALE: NTS
SHEET SIZE: D
REV: C
REFERENCE NO.:
SHEET: 2 OF 3
DWG NO.: E101

PLOT DATE: 9/28/2018



DRAFT

REV	DATE	CAD	ENG	DESCRIPTION	CM	PM
C	9/28/2018	RH		REVISED 30% DESIGN DRAFT PER CLIENT COMMENTS		DP
B	8/31/2018	RH	DB	REVISED 30% DESIGN PER CLIENT COMMENTS		DB
A	8/24/2018	TJM	DB	30% DESIGN SUBMITTAL		DP

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PRELIMINARY (30%) DESIGN, IN SITU THERMAL REMEDIATION SYSTEM, OU3, PVGCS SITE, WARREN COUNTY, NEW JERSEY

ELECTRICAL ONE-LINE DIAGRAM

SCALE: NTS
SHEET SIZE: D
REV: C
REFERENCE NO.:
SHEET: 3 OF 3
DWG NO.: E101

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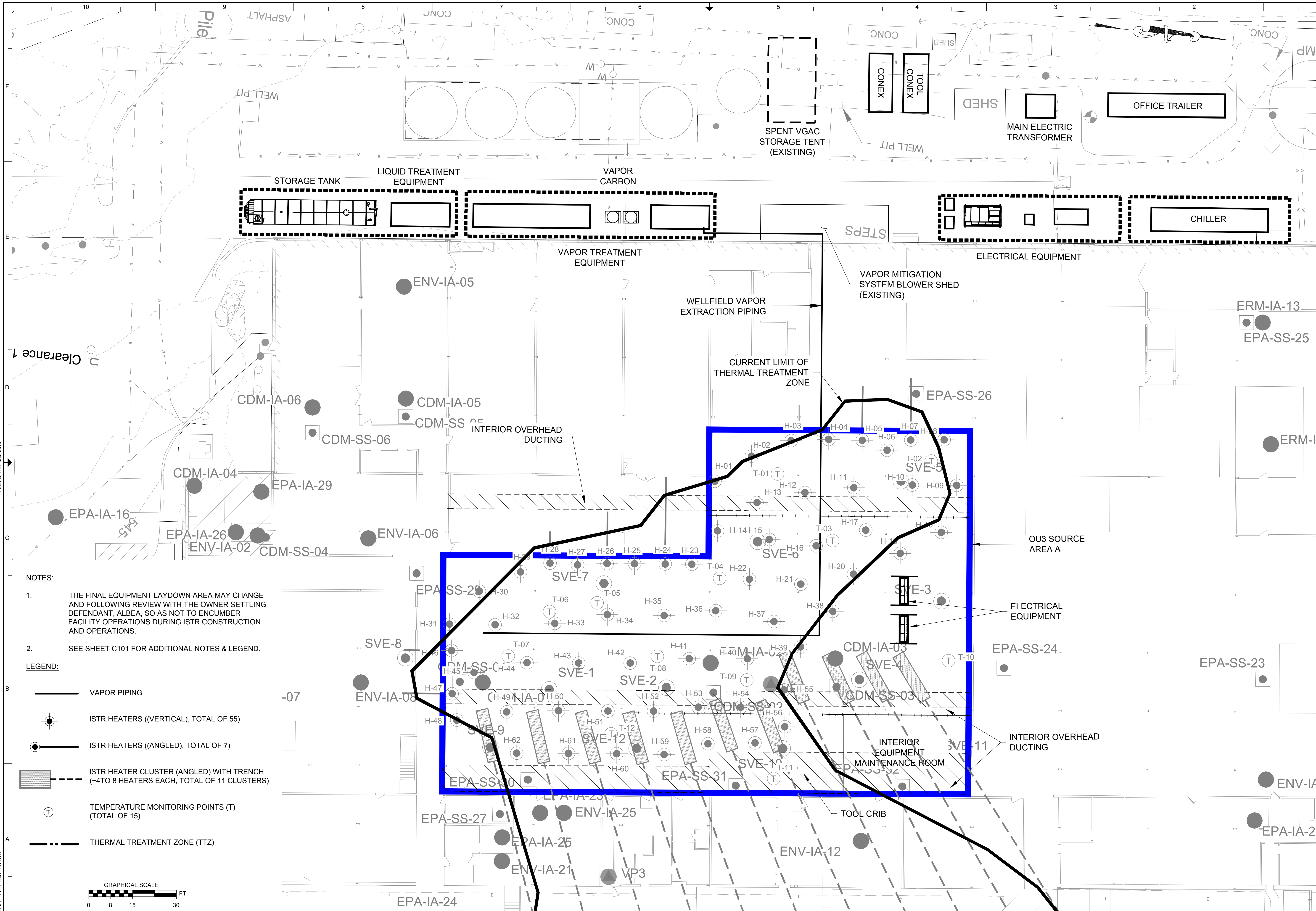
CTB FILE: TT-STANDARD.CTB



NOTES:

1. THE FINAL EQUIPMENT LAYDOWN AREA MAY CHANGE AND FOLLOWING REVIEW WITH THE OWNER SETTLING DEFENDANT, ALBEA, SO AS NOT TO ENCUMBER FACILITY OPERATIONS DURING ISTR CONSTRUCTION AND OPERATIONS.
2. SEE SHEET C101 FOR ADDITIONAL NOTES & LEGEND.

LEGEND:

- VAPOR PIPING
- ISTR HEATERS ((VERTICAL), TOTAL OF 55)
- ISTR HEATERS ((ANGLED), TOTAL OF 7)
- ISTR HEATER CLUSTER (ANGLED) WITH TRENCH (~4TO 8 HEATERS EACH, TOTAL OF 11 CLUSTERS)
- TEMPERATURE MONITORING POINTS (T) (TOTAL OF 15)
- THERMAL TREATMENT ZONE (TTZ)

GRAPHICAL SCALE
0 8 15 30 FT

REV	DATE	CAD	ENG	DL	DESCRIPTION
C	9/28/2018	RH	DB	DP	REVISED 30% DESIGN DRAFT PER CLIENT COMMENTS
B	8/31/2018	RH	DB	DP	REVISED 30% DESIGN PER CLIENT COMMENTS
A	8/24/2018	TJM	DB	DP	30% DESIGN SUBMITTAL

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PRELIMINARY (30%) DESIGN, IN SITU THERMAL REMEDIATION SYSTEM, OU3, PVGCS SITE, WARREN COUNTY, NEW JERSEY

MECHANICAL LAYOUT

SCALE: NTS
SHEET SIZE: D
REV: B
REFERENCE NO.:
SHEET: 1 OF 1
DWG NO.: M101

PLOT DATE: 9/28/2018

FILE: J:\PROJECTS\RAMBOLL - WASHINGTON NJ\01-DESIGN\001-DRAWINGS\0001-IN-PROGRESS DWGS\M101-MECHANICAL LAYOUT.DWG
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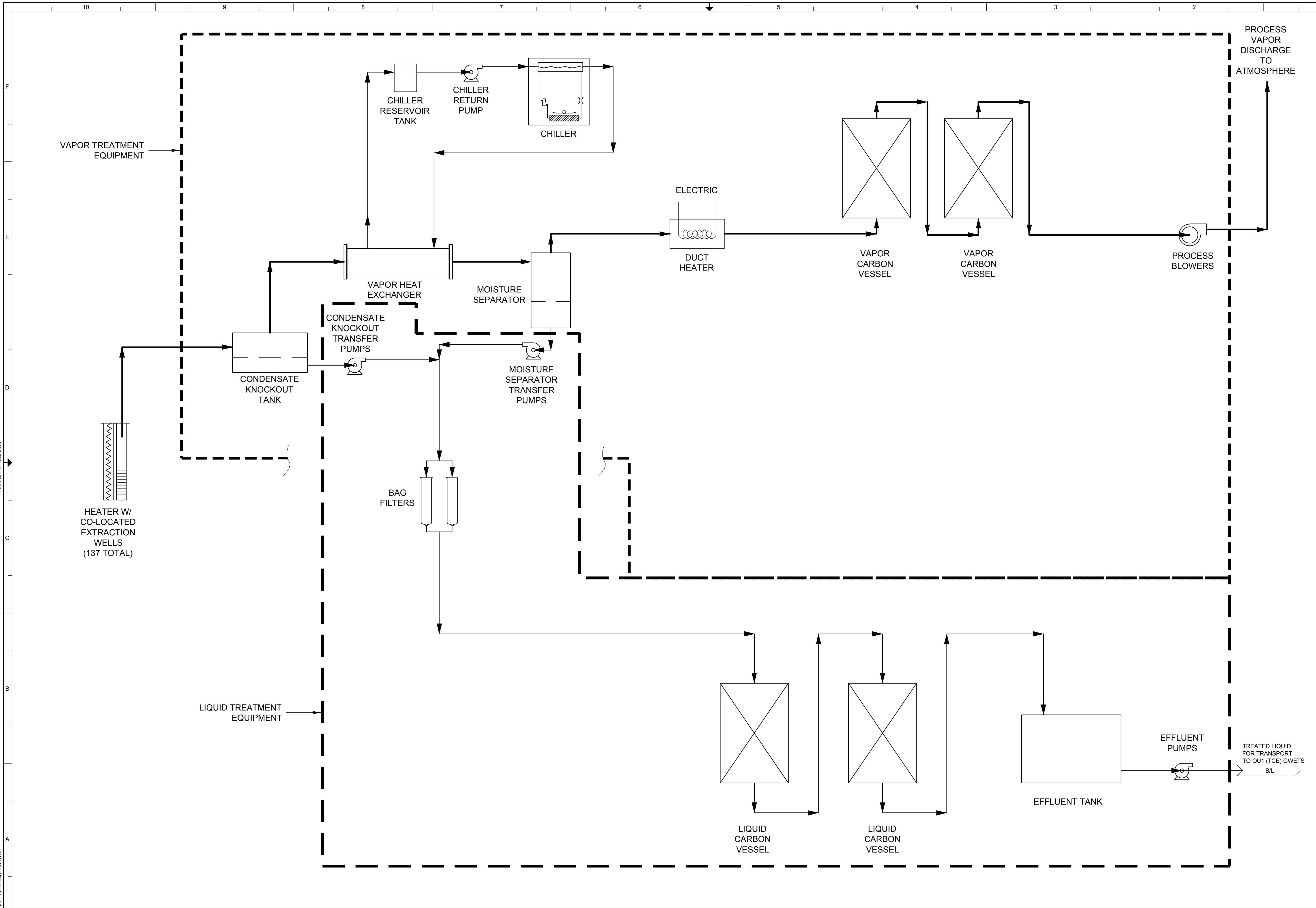

DRAFT

SEAL

REV	DATE	CAD	ENG	DL	DESCRIPTION	CM	PM
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B	8/31/2018	RH	DB		REVISED 30% DESIGN PER CLIENT COMMENTS		DP
A	8/24/2018	TJM	DB		30% DESIGN SUBMITTAL		DP

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PRELIMINARY (30%) DESIGN, IN SITU THERMAL REMEDIATION SYSTEM, OU3, PVGCS SITE, WARREN COUNTY, NEW JERSEY

PROCESS FLOW DIAGRAM

SCALE: NTS
SHEET SIZE: D
REV: C
REFERENCE NO.:
SHEET: 1 OF 1
DWG NO.: P101

PLOT DATE: 9/28/2018

FILE: J:\PROJECTS\RAMBOLL - WASHINGTON NJ\01-DESIGN\001-DRAWINGS\0001-IN-PROGRESS DWGS\101-PFD.DWG
CTB FILE: TT-STANDARD.CTB

APPENDIX C

TECHNICAL SPECIFICATIONS (TABLE OF CONTENTS)

DRAFT

List of Construction Specifications
Preliminary (30%) Design Report, ISTR, OU3

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- Work Restrictions
- Preconstruction and pre-work meetings
- Submittals/Submittal Procedures (for process piping/equipment inside Albéa facility)
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- Photo Documentation
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- Traffic Safety
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- Closeout Submittals

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- Listing and Description of Process Treatment Equipment
- Thermal Heaters
- Indoor Air Monitoring Equipment
- Air Treatment System
- Auxiliary Power Generator

APPENDIX D

CONSTRUCTION QUALITY ASSURANCE PROJECT PLAN

Version: Client Review Draft

Prepared for:
Pechiney Plastic Packaging, Inc.

Submitted to:
United States Environmental Protection Agency Region II
New York, New York

Date:
September 2018

Project Number:
1690008019

CONSTRUCTION QUALITY ASSURANCE PLAN
PRELIMINARY (30%) DESIGN
IN-SITU THERMAL REMEDIATION

OPERABLE UNIT 3, POHATCONG VALLEY GROUNDWATER CONTAMINATION SUPERFUND SITE
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CONTENTS

FIGURES

ACRONYMS AND ABBREVIATIONS

Albéa	Albéa Americas Inc.
ANC	American National Can Company
CQA	Construction Quality Assurance
GAC	Granular Activated Carbon
GWETS	Groundwater Extraction and Treatment System
NJAC	New Jersey Administrative Code
OU	Operable Unit
PVGCS Site	Pohatcong Valley Groundwater Contamination Superfund Site
PPPI	Pechiney Plastic Packaging, Inc.
Ramboll	Ramboll US Corporation
SVOC	semi-volatile organic compound
TCE	trichloroethylene
TCH	Thermal conductive heating
TTZ	Thermal treatment zone
USEPA	United States Environmental Protection Agency

1. INTRODUCTION

On behalf of Pechiney Plastic Packaging, Inc. (PPPI), Ramboll US Corporation (Ramboll) has prepared this Construction Quality Assurance Plan (CQAP) associated with the site activities to be implemented for construction of In Situ Thermal Remediation (ISTR) System for treatment of trichloroethene (TCE) in vadose zone soils in Source Area A of Operable Unit 3 (OU3) of the Pohatcong Valley Groundwater Contamination Superfund (PVGCS) Site located within the former American National Can (ANC) building at the facility presently owned and operated by Albéa Americas (Albéa) and located at 191 Route 31 North in Washington, New Jersey ("Site"). The Site is identified by the United States Environmental Protection Agency (USEPA) as ID# NJD981179047.

1.1 Scope and Objectives

This CQAP plan is to provide the information needed to coordinate the quality control procedures to be used for the construction of the ISTR System. This plan outlines the program to ensure that the ISTR System is installed in conformance with the Final (100%) Design for OU3.

The construction of the ISTR System for OU3 will include drilling for installation of heater/vapor extraction wells and temperature monitoring points, installation of piping, vapor treatment and liquid treatment systems, electrical power supply and control systems for the ISTR heaters, and setup site support trailer and data acquisition systems for monitoring of the OU3 remedial action.

1.2 Site Background

The Pohatcong Valley Contamination Superfund (PVGCS) Site encompasses an area of about 16.5 square miles (10,600 acres) that extends about 8.5 miles along the length of the Pohatcong Valley, which is a northeast-southwest trending valley bounded by mountains. The Site is divided into three operable units. Operable Unit 1 (OU1), which covers about 8.75 square miles extending about 5 miles along the Pohatcong Valley, is defined by the USEPA as the study area established to address TCE and tetrachloroethene (PCE) contaminated groundwater within Washington Borough, and parts of Washington and Franklin Townships. OU2 is defined by the USEPA as the portion of the Site downgradient from OU1 where TCE is present in groundwater. The OU3 Study Area is located in Washington Borough and has been identified by USEPA as a source of TCE contamination in soils contributing to contamination found within the underlying groundwater aquifer. The OU3 Study Area comprises four properties known as: ANC Area of Concern 1, Vikon Tile Corporation and Warren Lumber Yard properties.

1.3 Project Description

The current project focuses on remediation of Source Area A within ANC Area of Concern 1, which contains the deep TCE-contaminated soils underlying the southwestern portion of the former ANC building identified as the volume of soils to be treated in the USEPA's Record of Decision (ROD) for OU3.

The remedy selected by the USEPA as presented in the ROD includes the implementation of deep SVE and/or in situ thermal remediation to address deep soil contamination from TCE underlying the Albéa Washington Facility building. Based on the results of the Pre-Design Investigation (PDI) soil borings conducted and SVE pilot testing performed at the Site in the spring of 2018, ISTR along was recommended as the technology for remedial design and remedial action of the OU3 soils of Source Area A.

Accordingly, this CQAP pertains to the construction of the ISTR System for OU3 as described in the accompanying Preliminary (30%) Design Report. The ISTR system consists of Thermal Conduction Heating (TCH) borings, each with co-located vapor extraction wells (VEWs) installed within the zone of soil identified for treatment, the Thermal Treatment Zone (TTZ). Electric power is supplied to the heaters, heating the surrounding soils through thermal conduction. As a vacuum is drawn on the VEWs, steam and vaporized TCE is conveyed to on-site equipment for treatment of vapors and liquids.

The major components of the ISTR System include:

- TCH heaters with co-located VEWs,
- Vapor phase extraction and treatment equipment,
- Liquid phase treatment equipment,
- Electric power supply, transformers and control equipment, and
- Instrumentation and process control equipment.

2. CQA ROLES, RESPONSIBILITIES AND QUALIFICATION

2.1 CQA Organization

Construction of the ISTR System will be performed in accordance with the Contract Documents, the project-specific Health and Safety Plan (HASP), this CQAP, and the Final (100%) Design for OU3. The CQA/CQC activities will be performed by qualified personnel. Figure 1 provides a general Project Organization Chart for OU3.

2.2 Regulatory Authority

Pursuant to the Consent Decree and the OU3 Statement of Work (SOW), USEPA has authority over the OU3 Remedial Design and Remedial Action (RD/RA) activities.

2.3 Respondent

The organization or corporation that assumes overall project management and direction of the thermal treatment activities. PPPI is the Respondent under the Consent Decree for OU3 at the Site.

2.4 Design-Build Contractor (Engineer)

The Project Design-Build Contractor (Ramboll) has been retained by PPPI to provide CQA services during the implementation of the thermal treatment activities, and to document that the activities are conducted in accordance with this CQAP, design drawings, and project specifications.

Project Director - The Project Director will act as liaison between PPPI, PPPI's Project Coordinator and the USEPA. The Project Director serves as the primary point of contact for the OU3 RD/RA activities and is responsible for the preparation and implementation of this CQAP.

Design/Project Engineer - The Project Engineer will have the ultimate technical responsibility for the work performed. The Project Engineer will be also responsible for overall coordination of CQA/CQC activities. The Project Engineer must be a licensed engineer, be familiar with the OU3 Design Report and must be licensed in the State of New Jersey

CQA Officer and Observers - The CQA Officer will report to the Project Engineer and will be responsible for coordination of observation, sampling, testing, and documentation of construction activities. The CQA

Officer may employ specialists in particular aspects of the installation/operation to provide additional knowledge and experience. CQA observer(s) will be on site on a regular basis to document, collect samples and conduct field testing under the direction of the CQA Officer. CQA Officer responsibilities include:

- performing and documenting field and laboratory testing to be performed by the Engineer at the frequency established in this CQAP;
- performing and documenting field sampling for CQA/CQC testing;
- observing and recording procedures used for site preparation and remediation activities;
- coordinating samples to be sent to the CQA/CQC Laboratory;
- preparing daily reports;
- observing process equipment installation; and
- observing and recording start up and functional testing of process equipment.

Laboratory - The CQA/CQC Laboratory(ies) will be an independent testing laboratory to conduct testing, as directed by the CQA Engineer.

2.5 Remediation Contractor

A Remediation Contractor (Contractor) will be employed by the Engineer and PPPI to construct the ISTR System in accordance with the design drawings, and specifications. The Contractor will be experienced in the construction of the In Situ Thermal Remediation System presented in the design. Cascade Thermal has been chosen as the Contractor. A Contractor Project Manager, Implementation Task Manager, Site Supervisor and Lead Operator will be assigned to this project. The Contractor will provide evidence that the Site Supervisor and Lead Operator have had prior experience on similar projects and is familiar with the construction methods required on this project.

The Contractor(s) will have the following responsibilities associated with CQA procedures.

1. Review and be completely familiar with all the Contract Documents including but not limited to the OU3 Design Report and this CQAP.
2. Maintain a continuous line of communication with the CQA personnel to identify and discuss field issues as they arise.
3. Coordinate with all equipment suppliers to ensure compliance with the OU3 Design requirements.
4. Prepare and submit to CQA personnel all required submittals.
5. Identify potential design and/or construction issues as early as possible to allow resolution in a manner that will not impact the quality of the system installation and the schedule of start-up activities.
6. Maintain a continuous record of approved changes or modifications to the design report.

2.6 Required Meetings

2.6.1 Construction Kick-Off Meeting

Prior to the start of construction activities, a construction kick-off meeting will be held among representatives of PPPI, PPPI’s Project Coordinator, the Project Director, the Project Engineer, the CQA Officer, and Contractor Project Manager and Contractor Site Supervisor. The topics covered at this kick-off meeting will include, but may not be limited to, the following:

- familiarizing each organization with current site conditions, the site-specific CQA/CQC procedures, and this CQAP's role relative to the design criteria, plans, and specific information;
- reviewing the responsibilities of each organization;
- discussing the established procedures and protocols for deficiencies, repairs, and retesting;
- discussing procedures for the location and protection of equipment and materials, and for the prevention of damage of equipment and materials from inclement weather or other adverse conditions;
- conducting a site walk-through to review site conditions, including work areas and approximate limits of work, as well as staging and storage locations; and
- The construction kick-off meeting will be documented by the CQA Officer, and a meeting summary will be transmitted to all in attendance.

2.6.2 Progress Meetings

Daily meetings will be attended by the Contractor's Site Supervisor, the Engineer's onsite representative, Contractor’s construction personnel to discuss day-to-day operations, daily schedule, health and safety matters, coordination of construction activities, and general project status.

Weekly progress meetings will be held with the Contractor’s Project Manager, the Contractor’s Site Supervisor and the Project Engineer during the construction of the ISTR System. PPPI’s representative, the Project Coordinator for OU3, the Project Director, and USEPA may also attend some or all of these weekly progress meetings. The weekly progress meetings will be scheduled by the Project Engineer. Weekly progress meetings will be held to discuss issues including, but not limited to, project status, review of CQA observations, management of change, time schedule, scope of work, and overall project implementation.

3. CQA ACTIVITIES

3.1 General

Project monitoring will be performed based on a combination of the review for general compliance with the Final (100%) Design for OU3, submittal review, periodic project meetings, and onsite observation. The requirements of the Final (100%) Design for OU3 will provide the framework for CQA/CQC procedures. Such activities will involve the review of technical submittals; material/equipment testing, onsite observation, of testing, and review of the Contractor’s start-up activities.

Throughout the construction of the ISTR System, there will be various inspections and testing requirements for specific work tasks. In general, inspections to be conducted by the CQA Officer or CQA observer(s) include the following:

1. daily inspection of work in progress;
2. inspection of the material as it is delivered to the Site to check for any damage during delivery;
3. comparison of the material delivered to the Site with the specifications to ensure the proper material has been delivered to the Site;
4. inspection of materials after installation to verify that no damage occurred during installation;

5. a final inspection will be performed upon completion of each work task to verify compliance with the Drawings and Specification of the Final (100%) Design for OU3 and to ensure that deficiencies identified in the general inspections have been corrected; and
6. review of operational and functional testing of components.

A list of components of each work task which will require some form of CQA/CQC inspection and testing will be presented in the Pre-Final (90%) Design Report.

3.2 CQA Inspections/Testing/Reviews

Site inspections/reviews will be conducted by the Project Engineer and/or CQA personnel prior to, during, and at the completion of construction of the ISTR System. System functional and operational testing is to be conducted by the Contractor under observation of CQA personnel. Representative photographs of significant project features and progress will be taken during each inspection or test. The final CQAP to be presented in the Final (100%) Design will include a brief description of the site inspections, testing, and reviews to be conducted for the following:

- ISTR System components and equipment;
- Pre-final inspection;
- Functional and operational tests; and
- Final inspection.

3.3 Corrective Measures and Work Deficiency Meetings

Corrective measures will be required when results of construction, testing, or inspection identify a deficiency, as determined by the Project Engineer. Corrective measures include procedures to evaluate and correct the discrepancy to meet the requirements or the intent of Drawings and Specifications of the Final (100%) Design.

Quality issues which arise and require corrective measures will be documented by CQA personnel. The Project Engineer will be promptly notified of identified deficiencies that may require corrective measures. A special meeting may be held with a problem or deficiency developed. A summary of the meeting including a plan for corrective measure to address identified deficiency and follow-up actions will be documented by the CQA Officer. Following implementation of the identified corrective measures, the CQA Officer report to Project Engineer on the effectiveness of the corrective actions and document the measures taken for the project record.

4. CQA DOCUMENTATION

4.1 CQA Documentation

The CQA Officer will be responsible to ensure that a daily log documenting the work performed and completed by the Contractor is maintained. The CQA Observer(s) will issue to the CQA Officer reports summarizing the CQA activities including, at a minimum, visual observations, test results, problems encountered, and solutions achieved.

4.2 CQA/CQC Pre-Installation Submittals

The CQA Officer and Project Engineer will prepare a comprehensive list of required submittals and a schedule for submittal/approval. Pproposed modifications from the requirements of the OU3 Design

Drawings, and specifications must be shown and highlighted by the Contractor on the submittals. Submitted data will be reviewed by the Project Engineer as follows:

1. "Reviewed" if no objections are observed or no comments made.
2. "Reviewed and Noted" if minor objections, comments, or additions are made but re- submittal is not considered necessary provided the Contractor addresses the noted items.
3. "Resubmit" if the objections, comments, or additions are extensive. In this case, the Contractor will resubmit the items after revision.
4. "Rejected" if the submittal under consideration is not, even with reasonable revision, acceptable or when the data submitted are not sufficiently complete to establish compliance with the OU3 Design Drawings, and Specifications.

4.3 Close-out Documentation and Submittals

Contractor(s) shall submit the following documentation, if not already provided:

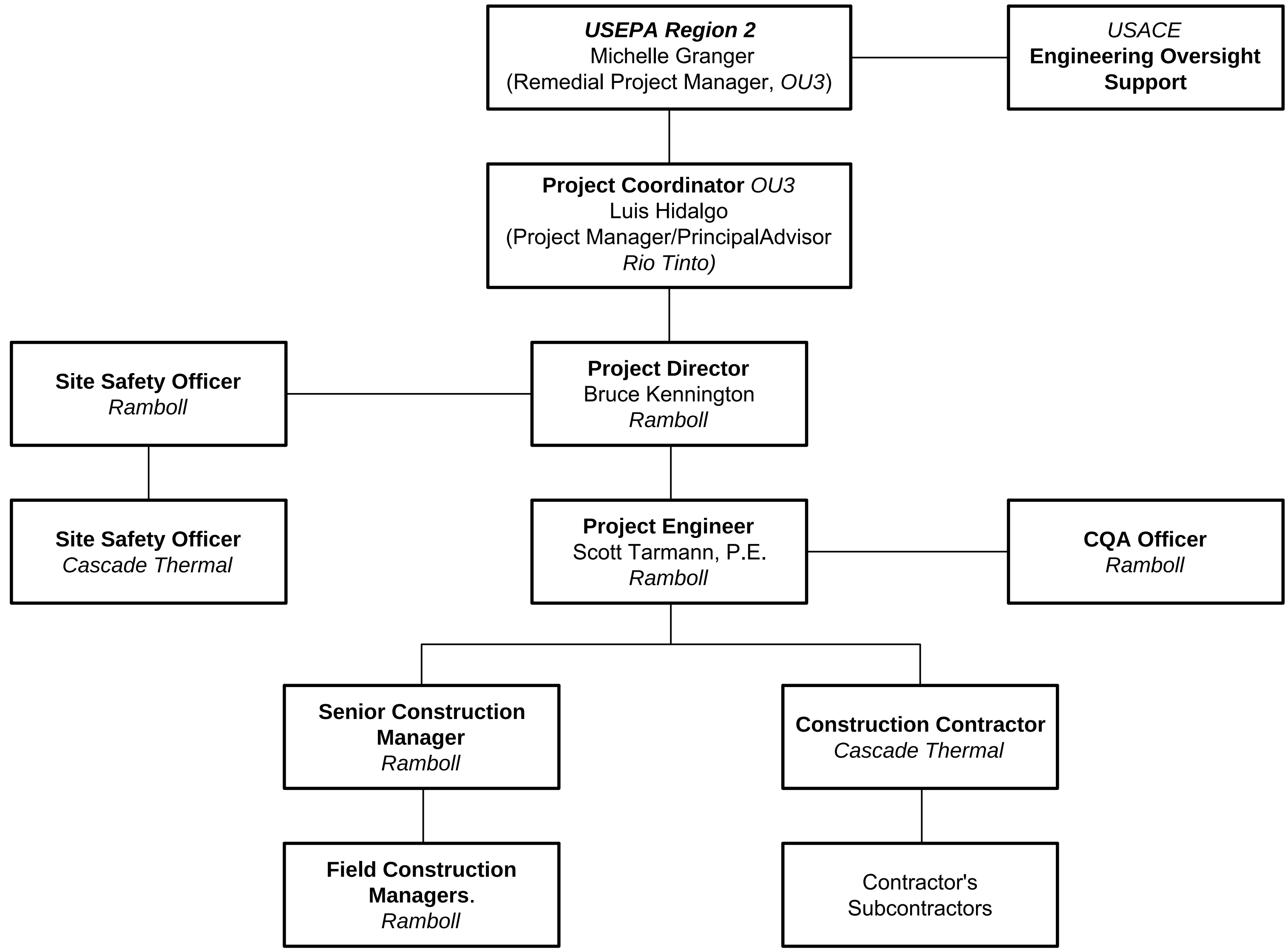
- as-built documents and drawings;
- operation and maintenance manuals;
- transportation and disposal documents, if applicable;
- copies of field testing reports and meeting minutes; and
- additional documents as requested by the Engineer, PPPI or USEPA.

4.4 Remedial Action Report

Pursuant to Section XII.B (Remedial Action Report) of the OU3 SOW, within 60 days of the date the USEPA's determination that construction of ISTR System is complete, PPPI shall submit a OU3 draft Remedial Action (RA) Report to USEPA for review and approval. The report will provide a summary of the work performed during the thermal treatment system installation and will be submitted to the USEPA in draft for review. The RA Report shall include a certification statement, signed by a responsible corporate official of Ramboll, which states the following:

> "*To the best of my knowledge, after thorough investigation, I certify that the information contained in or accompanying this submission is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.*"

FIGURES



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DRAFTED BY: APR | DATE: 8/31/18

PROJECT ORGANIZATION CHART

OPERABLE UNIT 3

POHATCONG VALLEY GROUNDWATER CONTAMINATION SUPERFUND SITE

WARREN COUNTY, NEW JERSEY

FIGURE

1

1690008019

APPENDIX E

WASTE MANAGEMENT PLAN

Prepared for:
Pechiney Plastic Packaging, Inc.
Lugoff, South Carolina

Submitted to:
United States Environmental Protection Agency Region II
New York, New York

Date:
September 2018

Project Number:
1690008019

DRAFT
WASTE MANAGEMENT PLAN

Operable Unit 3, Pohatcong Valley Groundwater Contamination Superfund Site Warren County, New Jersey

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CONTENTS

TABLE

APPENDIX

ACRONYMS AND ABBREVIATIONS

Albéa	Albéa Americas Inc.
ANC	American National Can Company
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
Cycle Chem	Cycle Chem, Inc.
Ramboll	Ramboll US Corporation
GAC	Granular Activated Carbon
GWETS	Groundwater Extraction and Treatment System
NJAC	New Jersey Administrative Code
OU	Operable Unit
PVGCS Site	Pohatcong Valley Groundwater Contamination Superfund Site
PPPI	Pechiney Plastic Packaging, Inc.
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
ROC	Regional Off-Site Contact
SVOC	semi-volatile organic compound
TCE	trichloroethylene
TCLP	toxicity characteristic leaching procedure
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

1. INTRODUCTION

On behalf of Pechiney Plastic Packaging, Inc. (PPPI), Ramboll US Corporation (Ramboll) has prepared this Waste Management Plan for the site activities associated with the in-situ thermal treatment system installation and operation for remediation of trichloroethene (TCE) impacts in vadose zone soils in Source Area A of Operable Unit 3 (OU3) of the Pohatcong Valley Groundwater Contamination Superfund (PVGCS) Site. The in-situ thermal treatment system is located within the former American National Can (ANC) building at the facility presently owned and operated by Albéa Americas (Albéa) at 191 Route 31 North in Washington, New Jersey ("Site"). The Site is identified by the United States Environmental Protection Agency (USEPA) as ID# NJD981179047.

This waste management plan is to provide the information needed to coordinate the off-site disposal of waste streams generated during the construction of the OU3 remedy as well as wastes generated during operation of the treatment system. The thermal treatment activities will include drilling for heater/vapor extraction wells and temperature monitoring points, installation of piping, condensation from process operations, vapor-phase carbon for air treatment of off-gasses, and wastes generated from system dismantling and demobilization at the completion of the project.

1.1 Summary of Waste Streams and On-Site Waste Management

Waste streams anticipated during the OU3 thermal treatment activities include the following:

- **General Construction Debris -** The general trash/debris do not require approval for off-site disposal and can be disposed of by the Contractor or in commercial dumpsters as appropriate. Discarded equipment may be placed with trash if free of any oil or hazardous substances.
- **Soil Cuttings -** Soils to be generated during the construction of the heater/extraction wells and temperature monitoring points are expected to be non-hazardous based on previous soil characterization testing. The waste soils are to be placed in rolloff containers to be supplied by the contractor.
- **Decontamination Rinsate -** Water from decontamination of down-hole drill casing, sampling equipment, and other equipment will be containerized and then sent through the on-site groundwater extraction treatment system (GWETS). Potable water used for any general cleaning or new pipe testing may be pumped to sediment filter bags and released for on-site infiltration, provided it has not contacted contaminated materials.
- **Expendable and Disposable Items -** Any waste hydraulic/lubricating/motor oils or used filters will be containerized and removed by the Contractor.
- **Spent Remediation Materials -** The proposed method for installation of thermal probes is sonic drilling which generates waste water. The drilling water will periodically be placed in totes and replaced with clean water. The drilling water totes are to be hauled to an on-site poly-tank for on-site GWETS for treatment then injection into the on-injection wells. Drilling water that is silty will be allowed time for settlement of most of the suspended solids prior to pumping to the GWETS. The settled fines will be placed in the soil rolloff box.
- **Remediation Process Waste Streams -** The proposed treatment method will generate waste granular carbon from both the vapor and the liquid treatment vessels. The waste carbon will be staged in vessels and labeled as used or spent carbon. A recycling service will be used to remove the spent carbon from the vessels and replaced with re-conditioned

activated carbon. The treatment process will also generate condensate water from heat exchangers and steam condensing operations. The condensate water is to be captured as noted in this design report and placed in temporary tanks, then transported to the on-site groundwater extraction and treatment system (GWETS) associated with the remedy for OU1 – TCE (Groundwater). If the condensate water requires pre-treatment prior to the GWETS, the contractor will treat the water using liquid-phase granular activated carbon. The GWETS will treat the condensate water and send it to the on-site injection wells. If acid waste is generated within the condensate during the vapor extraction process, it will be neutralized prior to treatment with activated carbon. The neutralized solution will be combined with condensate water and containerized for later treatment in the on-site GWETS.

The OU3 treatment is not expected to generate hazardous wastes.

1.2 Regulatory Requirements and Exemptions

Waste streams generated during the PDI activities at the Site that require off-site disposal shall be characterized in accordance with the Code of Federal Regulations (CFR), specifically 40 CFR Part 260 and 261, and N.J.A.C. 7:26 and handled in accordance with 40 CFR 300.440 (i.e., Off-Site Rule). The Off-Site Rule requires that Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) wastes may only be placed in a facility operating in compliance with the Resource Conservation and Recovery Act (RCRA) or other applicable Federal or State requirements so that wastes generated from response actions authorized or funded under CERCLA do not contribute to present or future environmental impact. In addition and as stipulated in 42 U.S. Code 9621(d)(3), "in the case of any removal or remedial action involving the transfer of any hazardous substance or pollutant or contaminant off site, such hazardous substance or pollutant or contaminant shall only be transferred to a facility which is operating in compliance with section 3004 and 3005 of the Solid Waste Disposal Act [42 U.S. Code 6924, 6925] (or, where applicable, in compliance with the Toxic Substances Control Act [15 U.S.C. 2601 et seq.] or other applicable Federal law) and all applicable State requirements."[1]

Section 121(d)(3) of CERCLA applies to any CERCLA response action involving the off-site transfer of any hazardous substance, or pollutant or contaminant (CERCLA wastes).[2] Should a hazardous waste stream be generated, an addendum to this T&D Plan will be submitted to the USEPA.

2. NOTIFICATIONS

2.1 USEPA Notification

In accordance with the Off-Site Rule, USEPA approval and determination of the proposed disposal facility's Off-Site Rule status is required prior to off-site transportation and disposal of the OU3 waste streams. Since the CERCLA Off-Site Rule approval is dynamic in nature, an initial status inquiry will be made with the USEPA Region in which the proposed disposal facility is located to determine the facility's status, and an additional status inquiry will be made approximately 1 week prior to shipment. All inquiries are to be made via email to the Regional Off-Site Contact (ROC)[3]. Contact information for Region 2 and Region 9 ROCs are as follows:

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1 http://www.law.cornell.edu/uscode/text/42/9621
2 http://www.epa.gov/waste/hazard/wastetypes/wasteid/offsite/index.htm
3 http://www.epa.gov/waste/hazard/wastetypes/wasteid/offsite/index.htm

- Region 2: Beckett Grealish
  - email: Region 2_OSR@epa.gov
  - phone: (732) 321-4341
- Region 9: Kandice Bellamy
  - email: bellamy.kandice@epa.gov
  - phone: (415) 972-3304

As requested by the USEPA On-Scene Coordinator, a Region 2 Off-Site Rule Request Form is to be completed for each proposed waste shipment (regardless of the destination region) and submitted with applicable waste characterization results to the USEPA Project Manager (Michelle Granger). A copy of the form has been provided as Attachment A for reference.

2.2 Waste Management Coordination

Ramboll is responsible for coordination with the Albéa facility to ensure that the waste soil temporary storage and removal is conducted to minimize disruption to facility operations. For containerized wastes, Ramboll and/or the Contractor will determine a date for waste pick up and locations of the truck staging, waste handling and loading so as not to impede the facility's operations.

Ramboll will be responsible for preparing waste profiles for acceptance by the off-site disposal facility. The Contractor will be responsible for the waste transportation and off-site disposal of the waste streams in accordance with application regulations.

2.2.1 Soil Waste

Coordination with the transportation contractor and disposal facility will be conducted by Ramboll in cooperation with project's Contractor. Ramboll will be responsible for waste profiling and landfill/facility acceptance. The Contractor will be responsible for the waste transportation and off-site disposal of all waste streams in accordance with application regulations. PPPI will be considered the Generator for all manifested waste disposal.

Soil waste streams generated during the OU3 work will be characterized via analytical testing and the results of waste characterization samples will be used to generate waste profiles. For the waste soils, a composite sample comprised of a set of 6 to 8 subsamples will be collected from the material contained in the roll offs and analyzed for toxicity characteristic leaching procedure (TCLP) VOCs and TCLP RCRA metals and/or any other waste characterization testing required by the disposal facility. All waste characterization samples will be collected and analyzed in accordance with the procedures identified in the Quality Assurance Project Plan (QAPP). Composite samples will be submitted to TestAmerica, Inc. in Edison, New Jersey. Results of the waste characterization will be evaluated in accordance with 40 CFR Part 260 and 261 and N.J.A.C. 7:26 to determine if the material is hazardous or if it meets the landfill's acceptance criteria.

Ramboll, in cooperation with RioTinto will then provide necessary paperwork to generate a waste stream profile. Once the Generator approves the waste profile, a signed version of the approved profile, in addition to the analytical results from the waste characterization, will be submitted to the disposal facility. The disposal facility will contact Ramboll with the decision for approval or denial of receiving the waste stream.

It is anticipated that waste soils slated for off-site disposal will be transported to ACV Enviro Cycle Chem, Inc. (Cycle Chem) facility in Elizabeth, New Jersey.

The Contractor will set up a tentative date for pickup at the Site, noting that adequate time must be allotted in this schedule for the Generator to receive the waste manifest for approval and signature prior to the transportation of waste. All roll-off boxes will be inspected by the Contractor prior to loading to ensure that they are secured, properly labelled, and intact for transportation. The non-hazardous waste manifests will be provided by the waste facility prior to the shipment of waste. Generator information is provided below:

- The generator Name and Mailing Address: PPPI c/o Ramboll, 333 W Wacker Drive, Suite 2700, Chicago, IL 60606 (phone 312-288-3800)
- The generator's Site Address: 191 Route 31 North, Washington, New Jersey

All waste manifests must be reviewed by Ramboll's Project Coordinator and RioTinto prior to waste pickup. Either the Generator will sign the waste manifest(s) and or alternately, the Generator may provide written authorization for Ramboll to sign manifests on its behalf.

2.2.2 Condensate

Condensate generated from the OU3 treatment activities will be containerized (poly tank or other tank) and disposed of via treatment through the on-site GWETS. If on-site treatment is not available, it is anticipated that the condensate will be profiled and transported to ACV Enviro Cycle Chem, Inc. (Cycle Chem) facility in Elizabeth, New Jersey for disposal.

2.2.3 Waste Carbon

Waste GAC from the treatment process will be temporarily stored on-site. Upon approval by the generator, the spent GAC will be transported off-site for regeneration/recycling. It is anticipated that the spent GAC will be sent to Evoqua Water Technologies LLC facility in Parker Arizona. However, alternate regeneration facilities may be proposed at that time.

3. WASTE TRANSPORTATION

Containerized wastes will be staged in a location determined by the Contractor in agreement with Ramboll and Albéa. Any roll-off boxes will be inspected by the Contractor prior to loading to ensure that they are secured, properly labelled, and intact for transportation.

Off-site transportation for applicable non-hazardous waste streams will be coordinated by the Contractor and the disposal facility. Ramboll will check with Albéa to ensure that the date and locations of waste hauling/pick up and handling does not impede the facility's operations. Prior to arrival on site, the transportation company will be informed of which site access route to use for the Albéa facility. A Ramboll field team member will be present on site with the signed manifest to oversee the handling and loading of all wastes.

TABLE

Table 1
Contact Information for Waste Disposal

Contact, Role Affiliation	Address	Phone Number/Email Addresss
Bruce Kennington, Project Director Ramboll	333 West Wacker Drive Suite 2700 Chicago, IL 60606	Phone: 312 288 3800 Email: bkennington@ramboll.com
Luis Hidalgo, Project Manager/Principal Advisor, OU3 Rio Tinto	4700 Daybreak Parkway South Jordan, UT 84009	Phone: 435 932 3965 Email: luis.hildago@riotinto.com
Michelle Grander, USEPA Remedial Project Manager USEPA Region 2	290 Broadway Mail Code: 19th Floor New York , NE 10007-1866	Phone: 212 637 4409 Email: granger.michelle@epa.gov

ATTACHMENT A
Region 2 Off-Site Rule Request Form

APPENDIX F

PRELIMINARY TCH SYSTEM COMMISSIONING CHECKLISTS

Cascade Thermal

Commissioning Document Review Checklist

Lead	Name	Checked	Date
Project Manager			
Process Engineer			
Project Engineer			
Electrical Engineer			
Programming Engineer			
Construction Supervisor			

Cascade Thermal

Commissioning Sign-Off Sheet

Item Description	Verified By	Date
Office Trailer Checklist		
Safety Systems Checklist		
Wellfield Equipment Checklist		
Wellfield Monitoring Instrument Checklist		
Electrical Power Checklist		
Collection & Process System Checklist		
Valve Position Checklist		
Control, Alarm, and Interlock Checklist		
Hazardous Energy Control Table Complete		
Emergency Generator Checklist		
Wellfield Installation Complete		

Problems/Comments:

Corrective Actions Taken:

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Office Trailer Checklist

Item Description	Problems/Corrective Actions	By	Date
Trailer blocked, leveled and anchored			
Stairs appropriately installed			
Following information is available for Air Permit: • Copy of permit/certificate • Any seven-day notices			
Sampling equipment & supplies stocked			
Housekeeping supplies stocked			
Full size prints of all approved for construction drawings are present for red lining			
O&M and OEM Manuals present			
Field Log Books on hand			
Computers set up with Process Screen (HMI)			
Internet connected and functioning - Verify dial in/out communication with PLC			
Check SCR power & control wiring to temperature controllers			

Cascade Thermal

Safety Systems Checklist

Item Description	Problems/Corrective Actions	By	Date
Site-specific training completed			
HASP available in trailer			
Health and safety monitoring complete			
Appropriate PPE stocked			
Lockout/Tagout supplies stocked			
Arc flash kit present			
Belt and/or shaft guards are installed			
Safety Data Sheets (SDS) available in trailer			
Decon station in place and decon materials provided			
Treatment area clear and organized			
Warning signs posted (electrical, flammable, exclusion zone, etc.)			
Barricades/Fencing around any exclusion zones (including signage)			
Fire extinguishers installed and inspection tags current			

Cascade Thermal

Safety Systems Checklist

Item Description	Problems/Corrective Actions	By	Date
Electrical cables and wiring covered/protected @ traffic areas			
Evacuation routes posted			
Emergency shutdown procedures posted			
Emergency contacts posted			
Safety Shower(s) and/or Eye Wash Station(s) installed and functional			
First Aid and Spill Kits in place			
Meeting with first responders completed			

Cascade Thermal

Wellfield Equipment Checklist

Item Description	Problems/Corrective Actions	By	Date
Inspect for damaged components			
Inspect for loose connections			
Thermal Conductive Heating (TCH) Wells			
Inspect electrical and thermocouple connections			
Confirm all circuit home runs are labled correctly and located for ease of identification.			
Continuity check on all heater circuits			
Ground (Megger) check on all heater circuits			
Heater resistance at distribution panel: check and record			
Remove orphan/stray wire strands @ heater lugs			
ETL sticker applied to inside lid of well head enclosure.			
Heater junction box covers closed			
Confirm secure ground wire connection on **ALL** heater wells			
Vapor Extraction Wells (VEWs)			
Confirm vapor connections at the wells are connected to the process vapor header via hose			

Cascade Thermal

Wellfield Equipment Checklist

Item Description	Problems/Corrective Actions	By	Date
Confirm any sample ports are closed (via valve or plug)			
When VEWs are operational, check for leaks			

Cascade Thermal

Wellfield Monitoring Instrument Checklist

Item Description	Problems/Corrective Actions	By	Date
Thermocouple function confirmed (based on ambient temperature reading)			
Confirm temperature/pressure monitoring point wells are properly labeled			
Confirm the heater circuit thermocouples are installed to the proper depths			
Thermocouple wiring checked			
Inspect thermocouple monitoring system - confirm all channels reading			
Confirm baseline temperature data collected			
Dataloggers installed and functional			
Pressure gauge calibration/zero confirmed			
Verify negative pressure in select wellfield pressure monitoring points under operating conditions			

Cascade Thermal

Electrical Power Checklist

Item Description	Problems/Corrective Actions	By	Date
Main transformer energized and inspected by local utility			
Check wiring at transformers and dist. panels: lugs tight, proper voltage, No-Ox on aluminum connections, etc.			
Check for damaged cable or areas that might require wear protection measures			
Transformers and distribution panels secured			
Proper grounding installed and checked			
Check wiring from distribution panels to process equipment, wellfield, and office trailer			
Verify phase rotation of motors at distribution panels and process equipment			
Panel voltage and high voltage warning labels in place			
Lockout/tagout materials available at site			
Arc flash kit is present			
Wellfield grounding/bonding jumpers in place			
Switchboard penetrations sealed against weather			
Check generator automatic transfer switch (ATS)			

Cascade Thermal

Collection & Process System Checklist

Item Description	Problems/Corrective Actions	By	Date
Check wiring and polarity to thermocouples			
Leak check process vapor piping			
Leak check process liquid piping			
Leak check utility water piping			
Leak check compressed air piping			
Leak check vent piping			
Install flow meters, transmitters, and verify function			
Check packaged equipment vendor's pre-start checklists			
Check motor rotation			
Verify proper belt alignment and tension on belt-driven equipment			
Test function of variable frequency drives (VFDs)			
Check motor amperage draw during operation & compare with rated values			
Wire process system instruments to PLC - confirm communication			
Verify PLC and programming is ready			
Vessels & Tanks			
Verify demister is installed on moisture separators (where applicable) *- Mist eliminator installed in S-102.*			
Verify pressure and/or vacuum relief valve is at the correct set pressure as specified on P&ID			
Confirm installation and correct operation of level switches/transmitters			

Cascade Thermal

Collection & Process System Checklist

Item Description	Problems/Corrective Actions	By	Date
Confirm installation and correct operation of pressure switches/transmitters			
Confirm installation and correct operation of temperature switches/transmitters			
Inspect nozzle connections - verify there are no leaks			
Confirm that all vent lines are opened			
Confirm that all drain valves are closed			
Verify that manway covers and blind flanges are installed and tight			
Verify installation of secondary containment around vessel as specified on P&ID			
Check that adsorption vessels (for example, GAC vessels) are filled with media			
Caustic System at Moisture Separator			
The caustic system (P-301A/B, T-301) will initially NOT be used on this project.			
Heat Exchangers			
On shell & tube Exchangers, verify That shell-side drain & vent valves are closed. *During startup, with chilled water circulating, open vent valve until all shell-side vapor has been vented.*			
Verify that spare heat exchanger is isolated from process & chilled water streams			
During startup, adjust manual butterfly valves on chilled water lines to the Vapor & Liquid Heat Exchangers to get desired flow/cooling.			
Verify bypass around heat exchangers is closed unless otherwise specified by project engineer/manager.			

Cascade Thermal

Collection & Process System Checklist

Item Description	Problems/Corrective Actions	By	Date
Pneumatic Double Diaphragm Pumps			
Double diaphragm pumps are located at the following locations: • S-101 - Condensate Knockout Tank • S-102 - Moisture Separator • OWS-201 - Oil/Water Separator			
Verify suction strainer is installed			
Confirm compressed air supply is tied into pumps			
Verify compressed air line contains filter, regulator, solenoid valve, & isolation valve			
Test pumps and verify correct operation (no liquid leaking out of muffler, etc.)			
Blowers			
Verify suction filter elements are installed and spare elements are stocked			
Check set point and operation of any pressure or vacuum relief valves			
Verify bearings have been oiled/greased and spare oil/grease is stocked			
Verify inlet guards have been installed on vacuum relief valve on suction side of Process Blowers			
Centrifugal Pumps			
Centrifugal Pumps are located at the following skids: • OWS-201 Effluent (P-203A/B) • Y-451 Chiller Loop (P-451)			
Verify suction strainers are installed			
Verify bearings have been oiled/greased and spare oil/grease is stocked			

Cascade Thermal

Collection & Process System Checklist

Item Description	Problems/Corrective Actions	By	Date
Inspect for any leaks near seal			
Chiller			
Verify Chiller Reservoir Tank (T-451) has been charged with water			
Verify hoses have been coupled to interconnecting equipment in the chilled water loop			
Follow checklists/instruction in chiller OEM manual			
Bag Filters			
Verify filter bags are installed and spare bags are stocked			
Verify filter bag lid is tightened and secure			
Inspect nozzle connections - verify there are no leaks			

Cascade Thermal

Collection & Process System Checklist

Item Description	Problems/Corrective Actions	By	Date
Oil/Water Separators			
Verify that coalescing plates are installed and secured			
Check Oil/Water Separator for any leaks, especially around nozzles			
Verify installation and function of slot skimmer			
Verify that any emergency pressure/vacuum relief valves have been installed			
Verify cover is securely bolted down to Oil/Water Separator			

Cascade Thermal

Valve Position Checklist

Item Description	Position	Checked	Date
Verify fail action on actuated valves	As Shown on P&IDs		
Wellfield Vapor Extraction Wells (VEWs) Header Isolation Valve (BF-101)	Closed		
Fresh air inlet (GA-801)	Open		
Equipment & piping drains	Closed		
Equipment & piping sample ports	Closed		
Equipment bypass valves	Closed		
Operating/online equipment isolation valves	Opened Unless Otherwise Stated in Checklist		
Spare/backup equipment isolation valves	Closed		
Instrument isolation valves	Opened Unless Otherwise Stated in Instrument OEM Manual		
Air supply valves to double diaphragm pumps (operating/online)	Manual Isolation Valves: Opened Solenoid Valve: OFF Position		
Air supply valves to double diaphragm pumps (spare/backup)	Manual Isolation Valves: Closed Solenoid Valve: OFF Position		
Regenerative or PD Blower suction & discharge isolation valves (operating/online)	Opened		
Centrifugal pump suction isolation valve (operating/online)	Opened		

Item Description	Position	Checked	Date
Centrifugal pump discharge valve (operating/online)	Pinched Closed; Slowly Open as Motor Comes to Speed		
Packaged vendor equipment	Per OEM Manuals		

Cascade Thermal

Monthly Maintenance Checklist

Item Description	Problems/Corrective Actions	By	Date
On rotating equipment, where provided, clean grease fittings and lubricate bearings and fittings. Replace dust caps or covers to prevent water or dust contamination of lubricant.			
On rotating equipment, where provided, inspect oil reservoirs and fill to appropriate level.			
Inspect pump seals for leaks.			
Drain blowers and fans where casing drains are provided.			
Inspect valve stems and bonnets for leaks. Tighten or adjust where appropriate.			
Isolate, drain, open, clean, and replace strainer elements.			
Inspect and install or replace plugs, caps, or blinds on terminal valves.			
Inspect wellfield manifold piping for leaks. Tighten if needed.			
Inspect instruments to ensure all plugs, caps, covers, or doors are firmly in place or closed to prevent water or dust intrusion.			
Inspect and test eye baths, fire extinguishers, emergency alarms, and other safety or emergency equipment, where appropriate.			
Put standby main blower into operation in place of currently operating blower. Check and grease bearings prior to starting blower.			
Work action on valves.			

Cascade Thermal

Monthly Maintenance Checklist

Item Description	Problems/Corrective Actions	By	Date
Other Monthly Maintenance Items			
Item Description	**Problems/Corrective Actions**	**By**	**Date**

APPENDIX G

OPERATIONS, MAINTENANCE AND MONITORING PLAN (TABLE OF CONTENTS)

CONTENTS

FIGURES

APPENDICES